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PROBLEMS OF PERSONNEL IN PUBLIC SERVICES

THE problem of personnel in the Civil Service and other public services cannot be considered altogether apart from the nature and range of the work which the post-war public services will be called upon to do, and this in turn is affected by the nature of the social and economic structure of the country. It is not only that free migration and interchange both between the national and municipal services and between these and the public or semi-public corporations is much to be desired, but rather that the essential social structure of the community and the relative importance of the service and the profit motives have important repercussions. It must obviously influence the underlying philosophy of the Civil Servant, whether the source of his inspiration be integrity and tendency to play for safety as in the past, or that more difficult part now needed of reconciling integrity and firmness of administration with the acceptance of responsibility and the capacity for co-ordinated initiative ; the character of the new machinery of government is also of fundamental importance. However far that passion for excellence insisted upon by Lord Haldane may sway a reconstructed Civil Service from top to bottom, it will not function with the desired efficiency unless the machinery of government itself is adapted to the new demands. Without any disparagement of a Service which has deservedly earned itself a unique reputation throughout the world, it is clear that adjustment, both of the personnel and of methods of working, is required to meet present and future problems.

Consciousness of this lies behind the views which have openly been expressed in the Press regarding Treasury control and the 'head' of the Civil Service, arising out of the appointment of a new Permanent Secretary of the Treasury. The real point at issue is that of the establishment control stressed in the Haldane report, later in that of the Tomlin Commission and still more recently in a P E P broadsheet. The headship of the Civil Service is an office of great and increasing importance, but it can no longer be usefully combined with the office of Permanent Secretary to the Treasury. The interest in war-time of getting a job done quickly and efficiently, the question of cost being subordinate, is at last compelling recognition in the Civil Service of the principles of staff management as it is understood and practised in modern industry.

Establishment problems are inherent in every form of complex industry and are the regular currency of industrial and business management. Moreover, though it would be rash to assume that all the solutions found successful in the competitive world are applicable to the organization of the Civil Service of Great Britain, the fact that no large concern has found the successful management of its establishment compatible with a close union of staffing and financial functions cannot be disregarded. Cost and economy are considerations fundamentally distinct

from those of efficient staff control, the object of which is to see that the right men are found for each job, and then that the conditions of their work are such as to offer the least hindrance to their doing the best that is in them. This is the main test of efficient selection, training, remuneration, promotion, welfare, retirement, or replacement problems, and in these allied questions of the development of efficient methods of working which constitute the essential staffing problems.

The attention which has been directed to such matters in that highly suggestive American report of the President's Committee on Administrative Management should be given careful consideration. Although much of the report is concerned with those problems of the machinery of government which are peculiar to the American constitution, there are sections of profound interest at the present time when the British machinery of government is under examination, and especially in connexion with the nature and extent to which Government control may have to be extended after the War and the manner in which such control should be exercised. Notably is this true of the comments of the report on staff matters and those fundamental principles of administration which are germane to any modern efficient organization.

One of the most important recommendations of this authoritative committee is the development of functional investigation and research into administration problems as a regular aid to management. "Economy and efficiency in government", says the report, "require constant investigation and reorganization of the administrative structure. It is a mistake to assume that government can be reorganized once and for all. A continuous study of the administrative organization of the huge Federal machine is necessary. New activities are constantly emerging and old activities are constantly changing, increasing or disappearing. Unless there is a special agency equipped to investigate problems of organization, new activities are set up without careful attention as to where they should be located and what kind of organization is required. On the other hand, when the need for certain government activities declines or disappears, unless there is a special agency constantly studying the organizational requirements, adjustments are made late or not at all."

The application of this argument to British conditions needs no further emphasis, and the fate of the Haldane report, to which this President's Committee's report is the American counterpart, though on a larger scale, is sufficient warning of the danger of continued neglect. In addition to the establishment of a Civil Service Administrator and a Civil Service Board to handle matters of recruitment and management of personnel, the report urges that a division of administrative research in the Bureau of the Budget is the logical place to develop these functions, and it is clear from the outline of the functions of the Division given in the report that the President's Committee has very clear ideas as to the Division's independence and freedom from defects which characterize Treasury control in Great Britain.

"The Division", says the report, "should stimulate the continuous study of organization, methods of procedure, at the departmental or bureau level by the Departments and Bureaux themselves. It should engage in such studies on its own initiative where necessary but should follow the policy of aiding and encouraging the Departments in the study of their own organization procedural problems. It should endeavour to develop principles of organization that have general applicability and to act as a clearing house, consultation centre for administrative research regarding the Department. Persons engaged in administrative research should be free from routine duties involving handling budget estimates. The administrative research activity should be concentrated in a separate division of the Bureau of the Budget. It should be headed by a permanent chief possessing in unusual degree imagination, vision, creativeness and analytical insight as well as intimate acquaintanceship with both the practices of government and the principles of public administration. The research division must be staffed with persons of unusually high competence. Important research assignments upon administrative problems can be carried out successfully only by highly trained and experienced persons familiar with the organization techniques of public administration."

The sanity and breadth of vision of this admirable report should earn for it widespread attention in Great Britain. Government, in its view, is a 'going concern', not a static institution. New activities should be organized on the basis of purpose, so that purpose may be the central driving force of the organization. While, however, new purposes cannot be achieved without broad freedom to experiment, when an activity is organized, its major policies established, its purposes accepted and understood, and its work in the main placed on a routine basis, the activity should be brought into the normal structure of organization and under the normal conditions.

The bearing of these observations on government problems in regard to reconstruction agencies is quite clear; those on the human aspects of government and the note that reorganization should be approached as a problem of morale and personnel fully as much as a task of logic and management are equally important. Nor are they irrelevant to the organization of the war effort. Honesty and courage alone are not enough for victory, either in peace or in war. Intelligence, vision, fairness, firmness and flexibility are required in an assembled competent strong organization of democracy. Strong executive leadership is essential to democratic government to-day—on that point there is complete unanimity among critics of H. M. Government both in the field of strategy and in that of production, and the American report urges that the forward march of American democracy at this point of its history depends more upon effective management of all its multitudinous activities than upon any other single factor.

From that opinion there will be no dissent. It is equally true in Great Britain, even when we remember that management is a servant, not a master, a means, not an end, a tool in the hands—and for the purposes—of the people. There can be no doubt that, as the two democracies continue to get "mixed up" in their affairs, in Mr. Churchill's phrase, their outlook and motives must interact powerfully on one another. The report of the Committee on Administrative Management will not pass unnoticed in Great Britain.

In a recent House of Lords debate Lord Portal endorsed Lord Reith's remarks about the importance of efficiency in the Civil Service. His statement was largely an outline of the procedure being adopted by the Ministries concerned with post-war reconstruction, but he agreed as to the importance of right timing in handling these matters, and that the necessary schemes for public services should be ready to put into operation at the appropriate time.

Without going into the details of the arrangements outlined by Lord Portal, it is clear that the Government is not unmindful of the importance of the machinery of government and the efficiency of administration. Nothing must be allowed to interfere, for example, with the handling of the transport question so that the greatest transport resources are brought to bear and used most efficiently during the War, but while any effective solution to transport problems is bound, as Lord Portal pointed out, to be controversial, the Ministry of War Transport is preparing its own scheme of reconstruction. Similarly, the Paymaster-General is examining the reorganization of electricity from the point of view of introducing a better diversity of load, greater standardization of voltage and uniformity of charges, adoption of a common policy with regard to development, and placing the best engineering advice at the disposal of all distributors. Water, which comes under the Ministry of Health, gas under the new Ministry of Fuel, Light and Power, and the location of industry under the Board of Trade, are other matters on which reports are at present being collated and submitted to a ministerial committee over which the Paymaster-General presides.

Lord Portal's statement will almost certainly reinforce the plea for wider powers for the new Ministry of Planning. The functions of the Ministry of Works and Buildings are only a section of those which require central co-ordination and direction, and though there are encouraging signs in Lord Portal's statement, the trend of the debates on war production and other matters in which the organization of government is of prime importance does not indicate that the Government in Great Britain has yet taken to heart the arguments so cogently advanced in the United States. It is to be hoped that the increasing contact with the United States and the constructive criticism of the Select Committee on National Expenditure and other bodies may not fail to have their due effect, and will lead to the adoption of the most effective tools and machinery to implement the national effort, no matter what departmental interests or traditional views may bar the way.

RELATIVITY ON PARADE

Introduction to the Theory of Relativity

By Prof. Peter Gabriel Bergmann. (Prentice-Hall Physics Series.) Pp. xvi+287. (New York : Prentice-Hall, Inc., 1942.) 4.50 dollars.

THE number of systematic treatises on relativity is not unduly large. This is partly because, since the first few years after Einstein's announcement of the 'general' theory in 1917, it has undergone no fundamental development, and partly because the early expositions were so good. One cannot forbear mentioning those of Eddington, von Laue, Pauli, and Weyl. But these were addressed mainly to professionals, and, in spite of subsequent accounts from various points of view, there is still room for a plain text-book suitable for undergraduates reading relativity as a special subject, or for research students needing a working knowledge of it. Prof. Bergmann's book is designed to meet such requirements.

The book is in three parts. The first constitutes a fairly comprehensive account of 'special' relativity ; it includes an introduction to tensor calculus, and the theory itself is presented in tensor form. The second is a concise account of 'general' relativity ; it consists mainly of a general study of the field equations and an account of standard rigorous solutions in special cases, together with a brief account of the experimental tests of the theory, and a sketch of recent work by Einstein, Infeld and Hoffmann showing how the field equations determine the equations of motion. The third is an introduction to 'unified' field theories, that is, those which incorporate also electromagnetic phenomena in a geometrical system as general relativity incorporates gravitational phenomena in its geometry ; after an outline of Weyl's gauge-invariant geometry, it provides a formulation of five-dimensional theory which can be applied to projective field-theories, to Kaluza's theory, and to extensions of the latter in which the author has been a recent collaborator with Einstein.

As is to be expected of a book commended in a foreword by Prof. Einstein, it has many admirable and exceedingly valuable features. But it is relativity on parade, a well-ordered march-past of selected units beautifully turned out in parade dress. It is *not* relativity in action, perhaps much less tidy, but full of verve in its adventurous penetration of new territories. Of course, from the parade-ground behaviour of a force, an experienced commander can infer how it will go into action. But to the uninitiated this is not so easy ; and one believes that something analogous will represent the experience of different classes of readers of this book.

The author says that "the main emphasis of the book is on the development of the basic ideas of the theory of relativity". Bearing out the foregoing criticism, one actually finds the emphasis falling unduly upon their formal development. Indeed, one wishes that some of the formalism of the development had been spared for the statement of the ideas themselves. Some of these, such as the reason for the linearity of the Lorentz transformation, the principle of general covariance, and the reasons for taking the world-lines of free particles to be ordinary geodesics and those of light-pulses to be null geodesics, are introduced rather casually and obscurely, and their implications by no means clearly brought out. In fact, the whole treatment of the postulates is neither compelling nor profound. For example, a

good deal is made of the fact that general relativity overcomes the difficulty of 'action at a distance' by providing a 'field theory' of gravitation. Surely a more comprehensible, while deeper, view is that we are anyhow looking only for a mathematical description of phenomena, and that general relativity provides a better one than classical theory by simply abolishing the dualism between space-time and matter.

There are two remarkable omissions: the cosmological applications of the theory and the fundamental problem of extracting 'observable relations' from the mathematical formalism. These topics have been largely responsible for the resuscitated interest in relativity in recent years and it is surprising to find them not even mentioned as part of "the development of the basic ideas" of the theory. Actually they have been treated at length elsewhere, for example, in a fairly recent book by Tolman, but that suggests another shortcoming of the present book: it contains references for the work that is described, but none for what is omitted from its limited scope.

There are some misprints, slips, and obscurities in the algebra, but those detected by the reviewer are not vital.

The book will prove a valuable adjunct to the teaching of relativity, but, in the reviewer's opinion, it could scarcely be relied upon by itself to give a student a well-balanced grasp of the subject.

W. H. McCREA.

IMMUNITY AGAINST ANIMAL PARASITES

Immunity against Animal Parasites

By Prof. James T. Culbertson. Pp. x+274. (New York: Columbia University Press; London: Oxford University Press, 1941.) 36*s*. 6*d*. net.

THIS most readable and interesting book is divided into three parts. The first discusses the general principles underlying natural resistance and acquired immunity to parasitic infections. The factors influencing natural resistance to parasitic infection are numerous and no one of them applies to all examples. The importance of the genetic constitution of the host is clearly shown in the differing racial resistance to malaria; negroes—even the very young before natural infection can confuse the issue—sometimes resist all efforts to infect them with *P. vivax*, whereas white persons are uniformly susceptible. Age also plays its part in resistance, and a complete chapter is devoted to the discussion of the various ways in which age influences immunity to parasites. Sex appears relatively unimportant although resistance to a few diseases is apparently influenced by this factor. Intercurrent infections usually result in depression of resistance but in some instances resistance to one parasite may be increased by simultaneous infection by another, as is demonstrated by the diminished pathogenicity of certain trypanosomes in mice infected with spirochætes compared to the same trypanosomal infection alone, and by the behaviour of different species of malarial parasites simultaneously infecting man. The character of the diet also influences profoundly certain parasitic infections; and although the most conspicuous effects are seen upon parasites residing in the alimentary canal, yet there is evidence of dietary influences on some somatic infections. The various organs and tissues also play their own special part in resistance to parasitic infection; the action of the reticulo-endothelial system is well recognized, but the effect of special defensive factors associated with other cells of the host and the influence of various invasive factors of the parasites themselves are not so commonly taken into account.

Turning to acquired immunity, the reader will find that therapeutic application has not perhaps made the progress that might have been hoped. This may well be because of the inherent complexity of the antigenic factors concerned, while an obvious teleological explanation is that the parasites so largely depend upon a tolerant balance between themselves and host. Nevertheless, a considerable amount of knowledge on the principles and mechanism of acquired immunity to parasites has accumulated since the first clear demonstration of such immunity almost fifty years ago, when Theobald Smith and Kilbourne showed that recovery from one attack of Texas fever protected cattle against subsequent attacks, and many aspects of parasitic immunity have been investigated, some with notable success. Premunition, local immunity and the influence of various mechanisms including skin response, agglutination and precipitin reactions, and the adhesion phenomenon are all discussed.

In the second section the various parasites are discussed separately and the specific immunological reactions associated with infection by them are described in detail. This section concludes with an interesting chapter on responses to arthropods, not only to bites and stings but also to somatic infection with such of them as infect the tissues.

The third part, which although short is not the least valuable, is devoted to applied immunology, and besides dealing with the practical diagnosis of parasitic infection by immunological means and the attempts that have been made to protect against such infection, gives an interesting chapter on the classification of parasites on immunological grounds.

It is clear that the chief developments have been in the field of the diagnostic tests for the various parasitic infections of man and domesticated animals, and in some diseases, particularly the somatic helminthiases, eminent success has been attained. These tests employ chiefly the detection of antibody in the tissues or blood, and so far comparatively little practical use has been made of tests for antigen, a matter for some regret since such tests would have the advantage of detecting infection in its earlier stages. Somewhat disappointing practical results have attended attempts to produce successful vaccines against parasitic infections and it appears extraordinarily difficult to reduce the virulence of an animal parasite while at the same time preserving its natural antigenic qualities. Nevertheless, as complete information becomes available, it appears more and more probable that no fundamental differences exist in the character of the immune responses to the parasites and to other agencies of disease.

Prof. Culbertson, as he himself states, has taken Taliaferro's classical monograph as his point of departure and he has worthily upheld the high tradition of the American school in this field of study. Not only has he most adequately sifted and summarized modern work, but also his text is most clearly annotated with references to original papers, and the book is therefore a very valuable review which should be in the hands of all interested in the subject.

F. MURGATROYD.

A STUDY OF DELINQUENCY

The Adolescent Criminal

A Medico-Sociological Study of 4,000 Male Adolescents. By Dr. W. Norwood East, in collaboration with Dr. Percy Stocks and H. T. P. Young. Pp. xi+327. (London: J. and A. Churchill, Ltd., 1942.) 45*s*.

THE inquiry carried out by Dr. East and his collaborators on Borstal boys is by far the most important official study of its subject, and appears at an opportune moment when the general public in Great Britain is much exercised over the alleged increase of delinquency among older lads. It carries forward, and in the main confirms, the earlier studies made of young delinquents of school age.

Between 1930 and 1937 nearly twenty-two thousand lads were received into Wormwood Scrubs prison, and examined in regard to fitness for detention in a Borstal institution. Of these, four thousand were made the subject of an intensive investigation A medical officer carried out a detailed physical examination and applied tests of intelligence; and supplementary data were systematically collected from parents, police, probation officer and school. Unfortunately, as was almost inevitable, no comparable sample, drawn from the ordinary law-abiding population of the same age and the same social class, could be investigated at the same time, so as to obtain a control-group. To some extent the limitation is corrected by the possibility of comparing the conditions among those convicted for different types of crime or those committing crimes with different degrees of frequency. The causal factors observed are classified under the headings that are now usual in such investigations; and the statistical significance of the differences found has been checked throughout by the appropriate chi-squared test.

The discussion of the results obtained begins with a survey of factors popularly supposed to be 'hereditary'. A family history of crime was reported in 5 per cent of the cases: it was somewhat more frequent among those convicted of offences against property and those with more than one conviction. A family history of insanity was found in 3 per cent: such a history was found more frequently among those convicted of sex offences, but was no more frequent among those with more than one conviction than among the remainder. A family history of psycho-neurosis was found in only 2 per cent; and "no significant result emerged from this aspect of the investigation". So far, therefore, hereditary factors would appear to play but a minor part.

Among environmental factors, the home conditions of the delinquent proved, as usual, to be of supreme importance. The average size of the families from which these young offenders were drawn ("5 children alive including the boy himself") was appreciably larger than the average size of comparable families in the population as a whole. There was, too, a significant association between the absence of one or both parents (particularly of the father), or the departure of an older brother or sister from the home, and the commission of multiple offences against persons or property. The presence of quarrelsome relatives, and particularly of quarrelsome parents, appeared to be a not uncommon factor where the offences had been committed against persons or against discipline. Lads under lax, careless, or repressive control, and lads who had lived away from home, showed a greater tendency to repeat offences.

Owing to the limitations of the inquiry, little evidence was available on the connexion between crime and poverty. It was noted, however, that convictions for sex offences were less common among lads coming from the poorer districts. The total percentage of time spent by these lads in unemployment was not apparently any greater than that so spent by the general population of the same sex and age; but at the actual date of committing their offences a large number were temporarily unemployed. Between high earnings and multiple convictions a well-marked association was observed; and Dr. East directs attention to the paradoxical conclusion that seems to follow: "attributes which determine a lad to commit multiple offences (initiative, aggressiveness, selfishness) may sometimes favour his earning capacity".

Turning to the personal characteristics of the lads themselves, we find detailed tables for bodily defects and diseases and for physical conditions generally. But, once again, inferences are difficult to draw owing to our ignorance about the prevalence of such conditions in the general population at this age. On the whole, as Dr. East points out, his data do not confirm Dr. Goring's conclusions, namely, that "thieves and burglars are inferior in stature and weight", and that "those convicted of violence are, if anything, above the average in general physique".

The psychological aspect of the inquiry was limited mainly, though not entirely, to the investigation of definite abnormalities. Nearly 4 per cent of the lads were found to be mentally defective—a proportion far higher than would be found among the general population; and of those who had attended primary schools, scarcely one half had succeeded in reaching the highest class. Dr. East rightly concludes that "the subjects taught in the ordinary elementary school must be made to appeal to this type of scholar, if his activities are to be directed into socially useful channels; and to do this it may be necessary to go outside the ordinary curriculum". On the temperamental side he draws a suggestive distinction between the more active and the more passive type of offenders, and points out that, when it comes to treatment, the latter often requires "little more than kindly guidance", while the more aggressive criminal needs "strict custodial supervision". Adolescent instability was a well-marked feature in many of his cases; but more specific abnormalities were comparatively rare: insanity and epilepsy, less than 1 per cent each, psychoneurosis only 1·4 per cent. What are so often regarded as mental abnormalities calling for medical investigation turn out to be merely exaggerated forms of the normal emotional changes that accompany puberty. "The importance of the biological aspect is shown by the fact that during adolescence certain inborn instincts, namely, those of sex, aggression, gregariousness, acquisitiveness and self-assertiveness, become more direct and importunate"; and, as the detailed classifications show, these characteristics "seem often to determine the direction which the criminal outburst takes". The notion, still popular with medical writers, that crime is a "form of illness" Dr. East most strongly repudiates; and here every psychologist will agree with him.

Of the practical conclusions deduced from this valuable inquiry, the most important is the need for further scientific study. In particular, a "centre for criminological research" is advocated, "from which special forms of research at other penal establishments should be directed".

CYRIL BURT.

THE PHYSICAL BASIS OF LIFE

Cytology and Cell Physiology

Edited by Geoffrey Bourne. Pp. xii+296+21 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1942.) 20*s*. net.

IT would be an interesting experience to obtain access to a contemporary review by an impartial music critic of the celebrated incident of "fiddling while Rome burned"; it might provide a helpful guide to the correct mode of approach to a volume composed, so the preface informs us, entirely during the 1940–41 air *Blitzkrieg* on Britain. The preface goes on to relate how bombs were probably audible during part of every chapter, that one essay was written in an air-raid shelter, another in railway trains, etc., until a reader may feel tempted to ask why, in these circumstances, were such difficulties not regarded as grounds for deferring publication? An answer to this can be given, but only after the book has been read, and it seems a pity that the producers themselves should have presented a work of scholarship to the scientific world in terms which suggest a peculiar form of A.R.P. Adverse circumstances can indeed provide an explanation for shortcomings, if such is required; but it is difficult to see that they can add anything otherwise to the scientific value of the result.

The book is actually a collection of essays by nine collaborators on a variety of topics almost all of which could be included under a heading such as aspects of cell structure and physiology in animals. Each essay has an introduction and most end with a conclusion. They could be read with equal profit in any order. The matter ranges from an eye-witness account of fertilization in a sea-urchin (p. 93) to the biochemical details of digestion in the grub of the clothes moth (p. 206); from the pure physics of protein monolayers (p. 58 *et seq.*) to the distribution of mineral components in the walls of the blood vessels of human patients suffering from arteriosclerosis (p. 179–82). A reader at the end of it all may be tempted to quote with respect to the book as a whole a sentence intended by its author to apply only to the last chapter (on pathological cytology), namely, that "the problems encountered in this survey have been many and varied, the gaps in our knowledge extensive, so that at the present time a synthetic discussion seems unprofitable", and to ask whether that was really the principal conclusion that the authors intended to convey?

In considering this question it is necessary to bear in mind not only the inevitable difficulties of composite authorship, but also the peculiar nature of the subject. It must be assumed that the larger problem to which this volume is intended to contribute is that of providing a physico-chemical description of cell structure and function. Such a description must ultimately entail the successful exploration of a region of space which is at present more inaccessible to observation than almost any other. The world of the microscope ceases to be visible at sizes below about a third of a micron; but the world made familiar by the ordinary tools of atomic physics and chemistry is not reached at once but only when the scale of significant distances has shrunk to the order of a few angstroms. The gulf between these two worlds may be gauged by the comparison that $1\,\mu = 10{,}000$ A., and in this almost uncharted region lies the structural framework behind almost all cytological problems, including fundamental issues such as the physical basis of life. A reader (or writer) who underestimates the immense and inherent difficulties of the ultimate problem will court disappointment deservedly.

The part that composite authorship has played in the presentation of the subject in the present instance may perhaps best be made clear by more detailed enumeration of the topics dealt with. The more significant of these may be selectively listed as: some chemical principles of cytological technique; experimental methods of studying unimolecular films; the plasma membrane; mitochondria and Golgi apparatus; some points of chromosome structure; microincineration; pathological cytology (including cancer). Clearly the synthetic discussion of all this material could only have been effected, were it possible at all, by one mind writing, and its absence here must be accepted as inevitable. The general impression conveyed by the book as a whole cannot therefore have been the principal object of writing it.

Composite authorship, on the other hand, has the merit, perhaps its only one, of making possible a more detailed and authoritative presentation of a greater variety of aspects of the main theme than can normally be supplied by one person. This is the case here. No single reader is likely to be equally versed in all the topics dealt with and something new and useful can scarcely fail to be learned by anyone interested enough to read the book carefully. Some things could, however, have been improved even within the selected framework. Thus the general inadequacy of representation of the botanical point of view is very obvious to a botanical reader, and is to be regretted in that, for some at least of the topics dealt with, botanical literature preponderates. This is conspicuously true for subjects such as protoplasmic permeability and spiral structure of chromosomes. In other places a timely reference to a plant, such as to the Fucus egg in connexion with artificial parthenogenesis, might have modified a general statement, while recognition of the relevance of some fields of plant pathology to an intractable cytological problem such as that of cancer would have enriched the book.

Another characteristic which may be expected to deter a reader from casual perusal is perhaps merely the reverse side of the book's most obvious virtue. In the attempt to overcome the undoubted difficulties of compilation, much of the matter tends to have been compressed together in a form closely resembling a catalogue. This may have its justification if completeness is thereby attained, but much is lost both in coherence and in power to stimulate thought. To quote one example, the work on the tobacco mosaic virus, mentioned among other matters on p. 243, is commonly regarded as one of the most important recent developments in the whole of biology; but this type of emphasis must be supplied, if at all, by the reader. The reader, in the same way, will have to extract, with some labour, from the close-packed pages of physics and biochemistry, the few really cytological facts which they contain, or, conversely, he may list on a piece of paper those few facts of sufficiently authenticated physics and chemistry to be found in the cytological chapters. The material is there, but the labour must be his.

In spite of these drawbacks the book does succeed to a considerable extent in achieving what must be regarded as its real and immediate object. This is something far humbler than the synthetic review of any one main theme, and may be thought of as the

presentation of a record or series of records of the state to which the selected topics had arrived up to and to a limited extent beyond the outbreak of war. In this it is successful in exact proportion to the degree in which the personal interests and work of each writer is or is not closely linked with his topic. Where sidelines have been introduced for the sake of an imaginary completeness the treatment may be so fragmentary that it were better omitted. A case in point is the discussion of the uses of polarized light on pp. 29, 30. Without any mention of important modern monographs, such as those of Schmidt (1937) and Frey-Wyssling (1935, 1938), or of the greatest work of an older generation, that of Naegeli (by which the micellar theory and the existence of crystalline properties in organic materials was first deduced), such a summary is almost worse than useless. On the other hand, the same writer on a later page has produced a highly interesting account of the nature of the cell surface as he sees it, which is valuable to the reader chiefly because the point of view (though not of course all the facts) is the writer's own and based on personal experience.

The fact that quite a large part of this book could be described in the latter terms is the best tribute which can be paid to it and one which sufficiently explains its publication in spite of difficulties. Deferment would not have improved it since the effects of cessation of international intercourse will be felt more and more as long as the War lasts and the difficulties of collating literature will not grow less. As a serious contribution to cytological literature this book deserves a place in every scientific library.

One word of kindly advice may, however, be offered to the cytological civilian who may have to face a new *Blitzkrieg* in 1942–43. Let him take this book with him into his dugout by all means, but let him also take two other volumes, namely, Gray's "Textbook of Experimental Cytology" (1931) and the Cold Spring Harbor Symposium on Nuclear Biology (1941). These will provide relaxation from the more solemn tasks of A.R.P. and remind him of the happier days when Rome was not on fire.

I. MANTON.

NEW LIGHT ON THE APOCALYPSE OF ST. JOHN

The Book of Revelation is History

By H. S. Bellamy. Pp. 204. (London: Faber and Faber, Ltd., 1942.) 8*s*. 6*d*. net.

MR. BELLAMY'S interpretation of the Apocalypse is entirely cosmological, being based upon the theory of the Austrian, Hoerbiger, concerning the attraction and ultimate destruction of satellites. Mr. Bellamy discovers in the Book of Revelation three cycles of myths, all concerned with a most appalling cataclysm which occurred thousands of centuries ago —the attraction and disintegration by the earth's gravitation of the satellite which was the predecessor of our present moon. He discovers further mythological material which he traces to a subsequent cataclysm which occurred when the planet Luna was captured by the earth's gravitation about fifteen thousand years ago, causing the sudden submergence of the continent of Atlantis.

The editor of the Apocalypse, says Mr. Bellamy, must have derived his knowledge from some esoteric source, either on the isle of Patmos where he went "for the word of God", or from some other source which the name is used to conceal. The first myth (Rev. i, 1–20) is a general survey of the scene before the disintegration began. The satellite would at this time appear to be very near the earth and brilliantly lighted. Thus a group of brilliantly lit craterlets might well seem to be a group of stars, and the face of the satellite would almost certainly be covered with grotesque shapes. The second myth (iv, 1–8) is a series of observations of these, in which the imaginative eye sees them as the four-and-twenty seats, the elders, and the beasts "who rest not day or night". The "sea of glass like unto crystal" indicates the glaciosphere of the satellite. When the disruptive pull of terrestrial gravitation began to outweigh the internal cohesion of the satellite, this glaciosphere would crack and split into slabs. These slabs would crowd towards the apex so that new forms, for example a 'lamb', a 'book', a 'throne', might appear. The actual beginning of the disintegration is seen as the 'opening of the seals'; then follows the account of the disintegration proper under the symbol of the sending forth of the four horses. The white horse signifies the white, or icy, stage, the red horse the ensuing stage in which the glaciosphere is entirely stripped away revealing the red soil beneath, the black horse the bare metallic core of the satellite, which under disintegration would shine livid in the light—the pale horse. The rain of blood is the fall of the red soil, and the star which fell from heaven opening the bottomless pit (ix, 1,2) a huge meteorite which pierced the terrestrial crust of the earth and penetrated to the magmatic strata beneath. Mr. Bellamy traces other references to this breakdown cataclysm in appendixes on Ezekiel, Ezra, Enoch and others.

Mr. Bellamy identifies "mystery Babylon" with Atlantis. "The great πολις was found no more, because this angel had thrown into the sea a huge white round object, like unto a mill-stone" (Rev. xviii, 21). Again quoting from the book of Ezekiel, "How art thou destroyed that wast inhabited by seafaring men, the renowned city that was strong in the sea. . . . Now shall the isles tremble in the day of thy fall; yea the isles that are in the sea shall be troubled at thy departure" (xxvi, 17–18). Space does not allow more than a reference to these survivals of Atlantis myths which the author traces.

Supposing this explanation to be scientifically probable, why should the editor of the Apocalypse have attached such religious importance to so purely cosmological a chronicle? The author makes the interesting observation that he lived at a time of great crisis when established codes of behaviour were losing hold of the masses, as at the present day. His work may therefore have been an attempt to show the relationship between religion and science, so as to disentangle religion from crumbling conventionalism. He may have been trying to use the history of these cataclysms to reveal the hidden relationship between the inner lives of individuals and the lives of nations and of the world, so as to dissolve the dividing wall which current ethics would set between the scientific and religious points of view. Such a book, then, while justly claiming absolute truth, would admit of different interpretations according to the religious development of the reader; for the fact that heaven and hell may be cosmologically interpreted does not preclude other interpretations on different levels of consciousness. The dead are still burying their own dead, and the living are still being led unscathed through the ten circles of hell.

B. M. B.

RELATION OF MINERAL RESOURCES TO WORLD PEACE*

By SIR THOMAS HOLLAND, K.C.S.I., K.C.I.E., F.R.S.

AMONG the raw materials referred to in the Atlantic Charter minerals are, beyond question, the most important because of their natural occurrence under fixed geographical conditions which cannot be changed by any artificial measures. They are essential to all technical industries; and, rightly or wrongly, applied technology has become an inevitable and ineradicable phase of our civilization. No civilized community can now exist without a sufficient, and sufficiently varied, supply of mineral products; substitutes for them cannot be provided, except to a very small degree, by other materials, natural or artificial, without increased cost and loss of efficiency. The demand for them is insistent and certainly will increase in the immediate future. The problems before us are therefore urgent.

Yet the workable deposits of useful minerals are distributed without regard to climate or established national boundaries. It follows, consequently, that, so long as difficulties are created among the nations for the exchange of such raw materials, there must always be potential friction between the 'haves' and the 'have nots'. One can even go further without intelligent contradiction and say that, whereas tariffs can hamper international trade in mineral products, no tariff can prevent the trade altogether without the immediate creation of conditions which are certain to lead to war.

It will not be possible here to do more than present one or two illustrations to show the importance of selecting this section of the Atlantic Charter for special discussion; and this limitation to mineral questions does not mean that we fail to recognize the similar significance of other raw materials.

But it is the speed of change in the international bearing of mineral questions which gives them special urgency. During the first thirty-seven years of this century, the output of ordinary steel in the United States increased five times, from about 10 to more than 50 million tons, and, to produce the output for 1937, three fourths of a million tons of manganese ore had to be imported as one constituent among the necessary raw materials. In the latter year, with the help of a protective tariff amounting to about 100 per cent of the import price of manganese ore, the United States did not produce enough of the ore from domestic sources to meet much more than about five per cent of that country's own essential requirements. (In giving these round figures I am not unmindful of the fact that research on methods for concentrating the large deposits of American low-grade ores shows some signs of possible success in times of high prices or during the emergency of war.) You can guess therefore what the result would be if an extension of the recent tendency towards nationalism went so far as to prohibit the export of manganese ore to the United States from the four or five principal sources—the British Empire which then produced one third of the world's total of six million tons, and Russia which produced another third, both countries, especially Russia, wanting a large share of their own outputs; while France, Germany and Japan, producing between them negligible amounts, wanted most of the remaining third.

Short of absolute prohibition, tariffs might conceivably force the United States to exploit more vigorously its own resources at home and in Cuba, with the result, however, that all known workable high-grade resources at the disposal of the American Government would be effectively exhausted within a few years. The world is so made that the chief steel-making countries—the United States, Great Britain, Germany, France, Italy and Japan—have little more than negligible resources of manganese ore to rely on within their own political boundaries, whereas the countries in which the mineral occurs in greatest abundance are but small consumers of it. During 1937, four fifths of the world's output of steel occurred in countries which produced only about two per cent of the required manganese†.

India is now producing about a million tons of steel annually, but uses for the purpose less than two per cent of its own output of manganese ore. Russia thus becomes an outstanding exception; for many years it has been the world's chief producer of manganese, and, unexpectedly to others, during the decade before 1937 increased its output of steel ten times, thus passing from the sixth to the third position among the steel-making countries.

Now we can speculate with some degree of certainty on one important reason why Germany suddenly broke her pact and invaded Russia. It is a prospective shortage of manganese rather than of petroleum which threatens disaster to Germany's munition supplies. Petroleum can be made to some degree and to an increasing extent from the abundant brown coal supplies in Germany itself, although this incurs the absorption of much technical man-power, and nearly sufficient natural supplies are obtainable from other controlled countries, especially Rumania. But of manganese, all the European countries under the domination of Germany cannot together produce more than a fraction of that necessary to feed the steel furnaces under German control. Before the War the countries now under German domination imported annually more than 1½ million tons of high-grade manganese ore. The most productive among them has never turned out a tenth of this quantity, and even that is of a relatively low grade. Before the War of 1914–18, both France and Germany had accumulated some stocks of manganese, but not nearly enough to see them through, and Germany, being hampered at sea, was finally in serious difficulty.

One cannot, however, be confident in estimating the stocks of manganese still available in countries now under German control, because, while there is evidence that Germany herself was very late in commencing to accumulate stocks of imported ore for emergency use, it is obvious that France began soon after 1922 and continued annually to import far more manganese than was necessary for her output of steel‡. This is but one of the many ways in which the French people and their Allies have been 'let down' by a few of their weak and treacherous political leaders.

Whatever doubt on this account there may be about Germany's access to reserves of manganese, one can be more certain about her anxiety to exploit some others of the varied mineral resources of the Soviet, and one of these is almost certainly the

* Substance of the opening address at the Conference on "Mineral Resources and the Atlantic Charter" of the Division for the Social and International Relations of Science of the British Association on July 24–25.

† Roush, G. A., "Strategic Mineral Supplies" (McGraw-Hill, 1939), p. 38.

‡ Roush, G. A., *op. cit.*, p. 68.

relatively rare metal platinum, which is wanted in fairly large quantities for various war industries as well as for the manufacture of nitrous explosives. Although the output of the precious metal has trebled during the past twenty years, the substantial sources of supply are still under the control of the united democratic nations, Canada producing about a half, Russia about one fifth, America and South Africa between them another fifth, supplemented by smaller quantities from the Republic of Colombia, Belgian Congo and Abyssinia.

The argument which I have used, based on our information about the natural distribution of manganese ore in the world, is no lonely illustration of the fact that the occurrence of mineral raw materials does not coincide even approximately with the national domains in which industries have been most highly developed. There are others of a similar type on which the continuance of present civilized activities are dependent, and the American Government, wisely listening to its scientific and technical advisers, has labelled a dozen such minerals, on this account, as strategic, that is, minerals on which the United States depend on outside—sometimes distant—sources, for those supplies which are absolutely necessary to maintain essential industries and therefore to ensure safety in defence.

Manganese came into general use soon after the invention of the Bessemer process in the middle of the last century, and well over 90 per cent of the metal produced in the world is now consumed in steel-smelting. Although the metal is thus consumed only in a way analogous to that of a medicine, there is no known substitute to take its place on a large scale, and so under present war conditions it becomes a 'key' product.

But out of the study of its function in this way, there arose some twenty-five years later a quite different use for the metal as a definite constitutent of the manganese-steel which was invented by the late Sir Robert Hadfield. His invention of manganese-steel opened up a new era in metallurgy, for it became the forerunner of a whole family of alloys of iron with relatively rare elements like cobalt, chromium, molybdenum, nickel and tungsten.

It was the discovery and extended use of these new alloys which changed, and changed on a large scale, the problem of supplies for the industrialized Great Powers. In the last century mechanical industries sprang up around areas containing deposits of the small number of natural products required in the manufacture of ordinary iron and steel; for example, around the British coalfields, in which there occurred associated supplies of iron ore, limestone flux and coking coal. When the local supplies of ore became exhausted, improved transport facilities enabled Great Britain to bring iron ore from Spain and Scandinavia. But then again when ferro-alloys, with their very special and previously unexpected properties, superseded ordinary steel, their constituents had to be brought from still more distant parts of the earth, and the whole problem of commercial success in industry, as well as security in war, thus assumed an entirely new configuration. For, in addition to the family of ferro-alloys, other metallic alloys of industrial importance were discovered, such as those largely made of aluminium and magnesium, combining low density with sufficient strength for aircraft construction. Nor indeed is the end of this avenue of metallurgical development in sight or even predictable.

A country like Great Britain, which was practically self-contained for the few and simple essential constituents of ordinary steel up to the last quarter of the nineteenth century, quickly found itself dependent on supplies from distant parts of the Empire, and even from foreign competitors. From the happy condition of congratulating itself, the new century found Great Britain, for example, looking to Canada and the Belgian Congo for cobalt, to British Guiana and France for aluminium ore, to Canada for nickel, to India and the Gold Coast for manganese, to China and Burma for tungsten. A new meaning was given to the importance of retaining command of the seas, which seems now to be giving place to command of the air.

These are but a few among many mineral products which are just as essential as imported food for our continued existence as a nation; and indeed more so, because no artificial effort can grow minerals where they have not been placed already by Nature. There are not and never will be available synthetic metals for industrial use. We can use plastic products for door knobs and ash trays to economize in imported copper and zinc for brass, but we cannot economically replace bauxite, which we must import for its aluminium, by aluminous clay which we have in abundance; and generally, while one metal can occasionally be used to replace another at greater cost and reduced efficiency, so far as Great Britain is concerned, we cannot produce even an inefficient substitute. But Great Britain is not unique in this respect. France, Germany, Italy and Japan, as independent units, are also dependent on the outside world in other ways and to different degrees. Even the United States can never be self-contained. Nor can any country derive comfort and security from its greater approach to self-sufficiency; for what is the use of being able to build a motor-car if we are dependent on another country for a sparking-plug?

So far I have spoken of essential minerals in qualitative terms. When we consider the situation quantitatively, the problem takes a much more serious aspect. The extension of our demands in kind is being accompanied by a correspondingly increased consumption in quantity, with one immediate and dangerous result that smaller deposits of useful minerals must be neglected for richer and larger masses which can be exploited in bulk. The pace in consumption has increased since 1900 on a scale which has resulted in a greater output than the total production of all previous history back to the Stone Age.

This comprehensive statement has been met, I know, with the criticism that statistical records do not extend back beyond the nineteenth century; but its accuracy can be checked by a simple diagram for any representative mineral used in the industrial arts and therefore can be applied to the whole. We might, for example, take a metal like copper as one which is familiar to everyone by its widespread use in a variety of ways. At the beginning of the nineteenth century the world produced about 10,000 tons of copper a year, by the middle of the century about 40,000 tons, and before the century finished, production had reached half a million tons annually. The curve of production went on rising, with only two serious setbacks, until it indicated in 1937 that the annual output had passed two million tons. It is easy to see that the area of the curve enclosed between 1900 and 1927 must necessarily exceed that of all previous periods since man became a metal-

lurgist. Similar curves, not always rising so steeply, tell the same story for other familiar metals.

This matter is not mentioned as a mere curiosity of industrial history: it is to show that, with the growth of national exclusiveness in recent years, there has sprung up an increased interdependence among the nations and especially among the greater Powers, beyond the control and, one can say with safety, beyond the mental comprehension of those politicians who have had most to say, and too much influence, on the international questions which have brought us to the present condition of universal war.

As one result of vague fears of aggressive trespass during the past twenty years, and in spite of isolated attempts to the contrary, the nations have become more and more self-conscious, and, with regard to their natural possessions of minerals, more inclined to conserve their resources. Many of them, the British Empire no less than others, have refused the grant of concessions to prospect for or to exploit mineral deposits, thinking through vague fear that some vital asset may thus be squandered; forgetting, however, that a mineral deposit cannot in an emergency be readily turned to account by the nation itself unless it is already developed, overlooking the fact that, even under war conditions, a mine cannot be taken out of the country in which it lies, and failing to realize that what matters is not the nationality of the mining company which risks its money in prospecting and mining, but in which country the mineral is finally prepared for use in the arts—the arts of peace or the arts of war.

Failure generally to appreciate the fact that civilization cannot go on at all without the international exchange of minerals has developed at times a general atmosphere of tension that cannot be relieved except by war. As no country can ever be self-contained in future for essential mineral raw materials, no nation can contribute its share to the progress of civilization without the operation of principles such as those outlined in the Atlantic Charter. But for democratic nations to implement those principles, it is necessary for the public to understand far more than they do now the part which mineral problems play in civilized activities.

In the United States the problems have been examined in critical detail for several years by selected committees of technological specialists, but naturally their chief object has been to provide military security for the nation in a world threatened by potential aggressors.

The Soviet Republics of Russia have done the same by official organizations, and most of the world seems so far to have failed to appreciate the extent of their resources or the realistic thoroughness which has actuated the present Government of the U.S.S.R. in the utilization of applied science.

Fifteen years ago, the British Empire Council of Mining and Metallurgical Engineers formulated proposals for a similar investigation of our scattered resources, but the Dominion Governments have apparently been dominated by the immediate problems of promoting inter-Empire commerce, and have consequently overlooked the dangers of national exclusiveness regarding mineral raw materials, which all well-behaved nations must reasonably obtain if civilization, such as we know it, is to survive.

At the time of the South African meeting of the British Association, I could see no further than a possible understanding—which is the first necessary step towards agreement—between the United States and the British Commonwealth, which between them, at the time, controlled three fourths of the world's workable deposits. My imagination takes me in the same direction still, but very little further along the road towards the development of an international conscience about the hoarding of mineral deposits.

Another serious effort should be made to formulate measures for facilitating the international flow of mineral products, keeping always in mind the simple circumstances that no country is or will be self-contained for mineral supplies, and no development of science can or ever will grow workable mineral deposits where they are not already formed by Nature. And I ought perhaps to repeat what I suggested at the beginning, that this question is by no means a matter of academic interest. It is one that must be settled and settled quickly by practical measures if civilization is to be saved for our descendants. Unless it is settled, and settled quickly at the end of the War, by an intelligent understanding among the successful Powers, newly concocted aggressive attempts to enforce control will lead intermittently to further outbreaks of war. Delay for more mature consideration may be the rashest step to take.

REFLEXION OF X-RAYS WITH CHANGE OF FREQUENCY

By SIR C. V. RAMAN, F.R.S.
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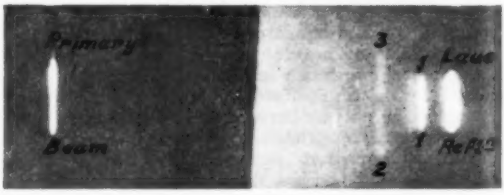
IN *Current Science* of April, 1940, photographs were published exhibiting the very remarkable phenomena observed when a pencil of X-radiation from a copper target traverses a cleavage plate of diamond and the resulting Laue diagrams are recorded with adequate exposures. The photographs showed monochromatic X-ray reflexions from the (111) planes of the crystal which were quite sharply defined at all settings of the crystal but which were evidently different from the well-known Bragg reflexions. As this phenomenon was inexplicable on the existing



Triple quantum reflexions by the (111) planes in diamond.

X-ray theories, it was interpreted as follows: X-ray photons traversing a crystal can exchange energy with it, giving up or taking on a quantum of energy corresponding to the frequency of one or another of the infra-red or high-frequency vibrations of the crystal lattice; the X-rays are then geometrically reflected by the lattice planes of the crystal with a change of frequency. Further study of the effects exhibited by the (111) planes of diamond showed them to be in complete accord with the ideas outlined in the article of April, 1940 (see accompanying

illustration). If the fundamental process stated is possible with diamond, it should also occur and be observable with other crystals. Investigations were made which showed that this is actually the case; these are described in a whole series of papers published in the *Proceedings of the Indian Academy of Sciences* and in *Current Science* from May, 1940, onwards.

The purpose of this article is to present a general account of these investigations, and in particular to show how the reality of the frequency changes in X-ray reflexion has been demonstrated and their magnitude determined from intensity measurements at various temperatures.

Earlier X-Ray Theories

The fundamental X-ray process stated above presents a formal analogy with the scattering of light in crystals with change of frequency discovered by me in 1928, except that we have a geometric reflexion of the X-rays instead of the diffuse scattering observed with ordinary light. Why the possibility of such a process is not indicated by the existing X-ray theories is a point of some interest. In this connexion, a memoir by Laue (1926) in which he discussed the effect of the thermal agitation on X-ray propagation in crystals is well worthy of study. Laue showed that assumptions of the most divergent character regarding the nature of the thermal agitation in crystals lead to closely analogous expressions for the temperature factor in the intensity of the ordinary X-ray reflexions. Hence, even a reasonably good fit of the temperature factor with the experimental facts in selected cases cannot be regarded as evidence that the theoretical assumptions from which it is derived correspond with reality. The position is, in fact, closely analogous to that arising in the theory of specific heats, where very different formulæ (Nernst-Lindemann, Debye, Born-Karman) all fit the facts in certain simple cases fairly well.

A completely different situation arises when we consider the secondary radiations from the atoms which do not appear in the direction of the usual geometric reflexions. Here, as Laue remarked, the changes of frequency arising from the oscillations of the atoms are of fundamental importance, since only radiations of absolutely identical frequency can reinforce or cancel each other by interference. Hence, the spectroscopic properties of the crystal are of the very essence of the problem. If, therefore, we start off with assumptions regarding these properties which do not correspond with reality, the deductions therefrom will equally fail to represent the truth. This, actually, is the situation of the Faxén–Waller theory of X-ray diffraction in crystals, which rests on Born's postulate of the cyclic lattice. Born's crystal dynamics is based on the same idea as the specific heat theory of Debye, namely, that the distinct frequencies of atomic vibration in a crystal are as numerous as the atoms themselves and accordingly form a continuous spectrum. This assumption is contrary to the experimental facts of spectroscopy. Several distinct methods of spectroscopic research agree in indicating that a sharply defined monochromatism of the frequencies of atomic vibration in the near and remote infra-red is characteristic of the crystalline state; for the same reason and to the same extent that a perfect three-dimensional periodicity of the static arrangement of the atoms in space is characteristic of crystals.

Dynamic Reflexion of X-Rays

If, following Debye and Born, we assume that the frequencies of atomic vibration are as numerous as the atoms themselves, it follows immediately that the secondary radiations arising from such vibrations have correspondingly numerous frequencies and are therefore incapable of reinforcing each other by interference. The effect of partitioning the mechanical energy of vibration into a very large number of distinct frequencies is also to reduce the energy of any particular vibration to vanishingly small proportions. Further, the vibrations of higher frequency would have relatively the smaller amplitudes. Hence on the assumption stated, no distinctive effects could be expected from the high-frequency vibrations, in spite of the fact that practically all the available degrees of freedom of atomic movement are necessarily associated with such high frequencies.

That the Debye-Born concepts of crystal behaviour are unreal is, however, evident from the spectroscopic data. For example, Bhagavantam (1930) found that the spectrum of monochromatic light scattered in diamond exhibits an extremely intense and perfectly sharp line with a frequency shift of 1,332 wave numbers, besides several other feeble lines with both larger and smaller frequency shifts. Nayar (1942) studied the blue fluorescence spectrum of diamond and the corresponding absorption spectrum in the near ultra-violet. On immersing the diamond in liquid air, these spectra appear resolved into discrete lines. The frequency shifts of these lines from the electronic band at 4152 A. common to both absorption and fluorescence were found to be positive for one and negative for the other, but otherwise absolutely identical. Nayar was thus able to discover and measure nineteen discrete frequencies in the lattice spectrum of diamond, ranging from 1,384 to 176 wave-numbers per centimetre. Considering the simplicity of the crystal structure of diamond, these facts can only be regarded as a direct experimental refutation of the Born dynamics.

We are therefore justified in rejecting the existing X-ray theories and striking out on a new path which has as its starting-point the observed monochromatism of the infra-red vibrations in a crystal. Each of the observed discrete frequencies of vibration is necessarily associated with a very great number of degrees of freedom; in other words, it represents a mode of vibration occurring similarly and simultaneously in great numbers of the lattice cells, if not in the entire crystal. Such a vibration would give secondary radiations of altered frequency having their origin in the cells of the lattice and having coherent phase-relationships: these would therefore be capable of reinforcing each other and giving a notable intensity in the direction where they agree in phase and a negligible intensity in other directions, in a manner closely analogous to that in which the ordinary Bragg reflexions of unmodified frequency arise. Complete identity of phase of the vibration in all the lattice cells would make the dynamic reflexions observable only in the same crystal settings as the Bragg reflexions. The spectroscopic facts, however, do not appear to demand such a rigorous identity of phase of the vibrations in all parts of the crystal. It may therefore be assumed that a certain variability of the phase is permissible; this idea is given concrete expression in the concept of phase-waves or planes of constant phase for the infra-red vibrations. The possible orientations of these phase-waves

would depend on a number of considerations, including especially the structure and symmetry of the crystal and the particular mode of vibration under consideration; such considerations, therefore, also determine the geometric law of the dynamic reflexion.

In view of the change of frequency, we must necessarily regard dynamic X-ray reflexion as involving exchanges of energy between the X-ray photon and the crystal, analogous to those observed in the scattering of light. It follows that the temperature dependence of the intensity of dynamic X-ray reflexion should be of the same general nature as that indicated by the principles of the quantum theory for the scattering of light in crystals with altered frequency. The important difference is that, in the X-ray case, we can only observe the summation of the effects appearing with enhanced and diminished frequencies. Taking note of this, it follows that the reflexions associated with vibrations of high frequency should show a relatively small temperature variation and reach their limiting intensity at moderate temperatures; on the other hand, reflexions associated with vibrations of low frequency should show a more marked temperature dependence and reach their limiting intensity at a very low temperature.

Observations with Diamond

The verdict of the spectroscope which compels us to reject the Debye-Born concepts of crystal behaviour is independently confirmed by the X-ray phenomena. In particular, the effects exhibited by diamond are of such a striking character that they are in themselves a complete refutation of the Born crystal dynamics and *per contra* confirm the essential correctness of the new ideas outlined above. The octahedral planes in diamond are equally inclined to the three cube faces of the crystal. If, therefore, the phase-waves for an oscillation of the alternate layers of atoms in the octahedral planes against each other along the common normal are parallel to one of the cube faces of the crystal, symmetry demands that phase-waves parallel to the other two cube faces should also exist and give dynamic reflexions by the same planes. Further, it is known that such an oscillation has a high infra-red frequency, namely, 1,332 wave-numbers, and that a line with this frequency shift appears in light-scattering with an intensity sensibly independent of the temperature. The X-ray observations show, in agreement with the new idea, that the (111) planes give, in general, three geometrically sharp reflexions which appear in positions which are in perfect accord with the phase-wave formula (see accompanying illustration) over the entire range of crystal settings in orientation and azimuth. Their dynamic character is shown by the fact that the angular separations of the reflexions from the primary beam are not invariable but alter with the setting of the crystal. Further, the intensity of these reflexions scarcely alters with temperature over a wide range from that of liquid air upwards. The intensity of the reflexions diminishes rapidly with diminishing phase-wave length, but neither their perfect sharpness nor their temperature invariance is influenced by an alteration of crystal setting.

The facts stated above are obviously impossible to reconcile with the belief that they arise from vibrations of the elastic solid type having a thermal origin. The supporters of the thermal-elastic theory of X-ray diffraction appreciate this difficulty and have therefore adopted the expedient of trying to remove it by various *ad hoc* hypotheses, for example, that "a strain which is cubic in symmetry is inherent in the majority of diamonds", or that "diamond is not a normal crystal". It is sufficient to remark that suggestions of this kind do not explain the observed facts and that they are physically meaningless. In an article on the physics of the diamond just published (*Current Science*, July, 1942), I have shown that these and other beliefs which have been expressed in recent physical literature about the diamond are without any foundation in fact. Limitations of space prevent a consideration here of further problems which arise, namely, the other modes and frequencies of vibration of the diamond lattice, the X-ray effects exhibited by other lattice planes and the influence on the X-ray phenomena of imperfections of crystal structure when such are actually present in diamond. A discussion of these questions would greatly lengthen this article without really helping to clarify fundamental issues.

Measurement of the Frequency Changes

Whether, in specially favourable cases, X-ray spectroscopy may succeed in directly exhibiting the frequency-changes which arise in the dynamic reflexion of X-rays is a matter for future research. Fortunately, however, the reality of these frequency changes may be demonstrated and their magnitude determined by a very simple method which is of universal application. The method depends on the fact that, according to the principles of the quantum theory, the temperature variation of the intensity of these reflexions depends on the frequency of the lattice vibrations responsible for their production. According to the present theory, this frequency would be independent of the setting of the lattice planes giving the reflexions. On the other hand, in the Faxén-Waller theory of "diffuse thermal scattering of X-rays", the reciprocal of the elastic wave-length and therefore also the frequency of the vibrations giving the "diffuse maxima of scattering" which appear in that theory vary with the setting of the crystal and may be given any desired small value by making the crystal approach the Bragg position sufficiently closely. By holding the crystal in such a position and lowering its temperature to that of liquid air, the "diffuse maximum of scattering" should then diminish in intensity nearly in proportion to the absolute temperature. Tests of this kind have been made at this Institute with diamond by Dr. Nilakantan (1940) and with numerous other crystals (carborundum, rock-salt, sodium nitrate and penta-erythritol) by Dr. Venkateswaran (1941). The experimental results are decisive against the Faxén-Waller theory and show in an unmistakable way that the high-frequency or infra-red vibrations of the crystal lattice and not the low-frequency or elastic vibrations are responsible for the observed dynamic reflexions.

X-Rays and the Infra-Red Spectrum

It is not to be expected that weak and imperfect crystals, for example, soft metals, organic crystals and the like, would give at ordinary temperatures dynamic reflexions which are as geometrically sharp as those observed with diamond. Nevertheless, the published observations with such crystals show that the half-widths of the "diffuse spots" are in many

cases, for example, hexamethylene tetramine and urea nitrate, only a small fraction of the separation of the spots from the Laue reflexions and alter but little with the setting of the crystal. These facts clearly indicate that the reflexions observed do not owe their origin to vibrations of the elastic type.

Apart from the points dealt with in the foregoing account of the subject, there is much experimental evidence of a different nature on record which supports the validity of the new approach to X-ray theory made by the present writer. To appreciate fully this evidence, one must be familiar with both the X-ray and the spectroscopic literature. The remarkable way in which the X-ray results illuminate and are illuminated by the facts of spectroscopy will then be evident. In particular may be mentioned the correlations which exist between the geometric characters of the modes of infra-red vibration, especially those of low frequency, established by spectroscopic studies on light-scattering, and the observed intensities of the dynamic X-ray reflexions by the various lattice planes in the crystal. Such correlations are particularly striking when the molecules or ions in the crystal have planar configurations, and their translational and rotational oscillations have low frequencies (as is generally the case); the crystal planes nearly parallel to the ions or molecules then give intense dynamic X-ray reflexions.

NEWS and VIEWS

Scientific Exhibition in Moscow

An exhibition devoted to the cultural relations between the University of Moscow and the universities and scientific institutions of Great Britain and the United States is now open in one of the halls of the University, where the bomb damage suffered in an enemy raid last year has now been made good. The exhibits include many editions of the scientific works of Faraday, Clerk Maxwell, Scott and others, and correspondence between British and American men of science and members of the Russian Natural History Society. Of special interest is a section reflecting the scientific relations between Russian and British scientific workers. There is the unpublished correspondence between Lord Kelvin and Prof. Umov, who was an honorary member of Cambridge University. There is also a selection of letters exchanged between British and American botanists and zoologists. One of the exhibits is a photograph of the famous Russian naturalist Timiryazov wearing the robes of a doctor of the University of Cambridge.

A section devoted to Charles Darwin contains his correspondence with Russian men of science, and a copy of a book written in support of his theories by the Russian zoologist Mensbir, who was one of the first to defend them. Copies of Russian translations of Darwin's works are shown, together with material from the many celebrations in honour of the great British naturalist which have been held in the U.S.S.R. from time to time. Exhibits illustrating the work of Moscow savants who have lived and worked in the universities of Great Britain and the United States are a special feature. One of those is Prof. Pavel Vinogradov, who has made the medieval history of England and Italy his special subject. He worked for some time at Oxford, and was honoured with a knighthood by the British Government. His colleagues elected the aged Sir Paul Vinogradov to the responsible post of chairman of an international commission charged with the preparation of a new edition of a dictionary of medieval Latin.

Other figures to which prominent reference is made at the exhibition are Prof. Peter Kapitza, who has been closely connected with both Soviet and British academic life, Pavlov, Prof. Samuel Harper, of the University of Chicago, and Sir Bernard Pares, of the University of London. A large section is devoted to the exchange of books between the University of Moscow and the principal universities of Europe and America. During the past two years the University of Moscow has received more than 4,500 scientific publications from 320 cities throughout the world.

Cultural and Scientific Mission in China

Dr. Joseph Needham, F.R.S., of the Cambridge Biochemical Laboratory, has recently accepted a mission of cultural and scientific co-operation, on behalf of the British Council, to China. In Chungking he will be attached to the National Academy of China (Academia Sinica). He will carry letters of greeting to Academia Sinica from the Royal Society and the University of Cambridge, and to other Chinese organizations from the appropriate British bodies. He expects to visit most of the Chinese universities, and to facilitate the supply of scientific apparatus and books from India with the help of the Indian Government. It is probable also that he may be able to help the interchange of scientific and technical information between China and the other United Nations. For this purpose he would be glad to receive any suggestions bearing on the problems of scientific liaison, or any questions of specifically Chinese relevance; after the end of the present month, he may be reached c/o British Embassy, Chungking, via Foreign Office, London.

Man-Power in Physics in the United States

The War Policy Committee of the American Institute of Physics has issued a report surveying the man-power problem in physics in the United States. It is stated that there are only 7,000 physicists in the United States, the large proportion of whom are doing vital war research. This leaves too few for the training of the large numbers of men needed for the operating and maintaining of technical mechanisms like aeroplane and submarine locators, signalling devices, anti-aircraft fire control, etc. The Committee estimates that some 200,000 men and women will require training in physics within a year. These will be mostly next year's college and university students, who expect to enter the Army or Navy reserve training courses to be carried out at these institutions, and they will have to be taught by staffs already considerably depleted for war research. The Committee urges therefore that every possible step be taken to increase physics man-power of the United States and to use the present supply in the most effective manner. It recommends the establishment of Government-sponsored teacher-training courses, the adoption of wise occupational policies by the Selective Service System, financial aid to qualified students so that they may continue and finish their studies (especially graduate students who are already taking a large part of the teaching load),

and use of physicists in the Army and Navy only for work requiring their training. The Committee states that there is not sufficient understanding of the importance of physics in the war effort, especially on the part of the general public and of some local boards of the Selective Service. To remedy this, it is suggested that a public relations programme be commenced to educate the general public to the position, and to impress on students and teachers of physics the importance of continuing their work.

Control of Opium and Other Dangerous Drugs

MEETINGS in connexion with the international control in narcotics have just been held in London under the International Conventions concluded in 1925 and 1931. The Permanent Central Opium Board, which exercises, under the auspices of the League of Nations, the supervision over the manufacture of, and trade in, opium and other dangerous drugs in all parts of the world, has held its forty-first session. It was attended by Sir Atul Chatterjee, president (India), Mr. Herbert L. May, vice-president (United States of America), Sir Malcolm Delevingne (United Kingdom), Mr. J. H. Delgorge (The Netherlands), and Dr. George Woo (China). The Board carefully scrutinized the world position as it appears from the statistical reports sent in for the year 1941 by fifty sovereign States and some sixty-six dependencies and colonies and other territories. It also considered certain questions of policy and solutions of problems arising from the special circumstances of the War. Under the terms of the Conventions, the Board's report on its work is being sent to the Secretary General of the League of Nations.

The other international organization operating under the Conventions, namely, the Supervisory Body, has the task of examining annual estimates sent by Governments of their drug requirements, and members of it met for consultations to consider questions arising on the estimates for 1943, and issuing the Supervisory Body's annual statement on world requirements of narcotic drugs for that year.

Collaboration in the British Empire

THE Peter Le Neve Foster Lecture on "Empire Relations", delivered by Viscount Bennett before the Royal Society of Arts on June 3 (*J. Roy. Soc. Arts*, **90**, 613; 1942), gives a lucid survey of the development of the relations between the parts of the British Empire from the sixteenth century to the organization of the present Imperial Conference system in 1907, when these conferences became a fixed method of consultation between the self-governing Colonies and Great Britain and one another. Mainly from a constitutional point of view, Lord Bennett gives an account of the further development of the system and its limitations, notably its failure effectively to promote Imperial development on scientific lines. Imperial conferences since 1907 have been concerned with almost every conceivable subject, including communications, patents, development of Empire resources, research, timber reserves, wool production, etc., but while they have afforded an opportunity for representatives of all the nations of the Commonwealth to meet one another and discuss personally Empire problems in the light of their experience and special knowledge of their own communities, they have led to no agreement upon any adequate method for providing continuous consultation on matters of common concern. Urging the need for an earnest effort to make the story of the Empire better known to the youth of Great Britain, Lord Bennett stresses the importance of providing the means for adequate and continuous consultation. This is essential for common action by the Governments of the Empire to attain a common end, and he suggests that a member of each of the Governments of the Overseas Dominions might be resident in London. Regular meetings between the Prime Ministers or representatives of their several Governments, utilizing air transport and with a permanent secretariat, might provide a solution of the problem.

A Proposed World Calendar

THE World Calendar Association, Inc., New York, has published details for a proposed new calendar to commence in 1945 ("The World Calendar—A New Calendar for a New World." Pp. 32. World Calendar Association, Inc., 630 Fifth Avenue, New York). On the basis of a 364-day year, the year is divided into four quarters, each of 91 days. The first month of each quarter contains 31 days and each of the others 30 days, and January, April, July and October contain each 31 days. Every year and in consequence every quarter begins on a Sunday, and it is suggested that the national holidays of every country can be arranged to come on Mondays, if the people wish it, thus producing long week-ends. Christmas Day falls on Monday every year, and it is suggested that Easter should be the second Sunday in April, that is, April 8. As a result of fixing Easter for this date, the other movable Christian festivals, Ash Wednesday, Good Friday, Ascension Day, Whitsunday, etc., would occur on the same date every year. Such a stabilization of the hitherto movable festivals would place Advent Sunday on December 3 and Trinity Sunday on June 3—exactly six months apart. The 365th day will be at the end of December and it is recommended that it should be designated as a World Holiday by all countries accepting the new calendar. This World Holiday is an extra Saturday, called the Year-End Day. Leap Year Day is placed at the end of June, in the middle of the year, and it is also an extra Saturday and a World Holiday. The beneficial effects of the reform are explained in connexion with the various phases of life—industry, labour, Government, law, finance, science, etc.; and an appeal is made to the citizens of different countries to lend their support to the scheme.

The Problems of the A-Type Stars

Otto Struve and P. Swings have an article with this title in the August issue of the *Observatory* (No. 809, 64, August, 1942). Morgan pointed out about seven years ago that there is some physical factor other than temperature and surface gravity concerned in the production of the spectra of these stars. The theory of ionization has failed to solve the problem, and the authors are convinced that existing interpretations, which are very unsatisfactory, should be abandoned. They believe that a new solution should be attempted along lines which have been forced on them by the results of their recent work on stellar shells, Wolf-Rayet stars and planetary nebulæ. It is suggestive that certain peculiarities occur in that region of the sequence of the stellar spectra where the Lyman lines and the Lyman continuous absorption cause a large redistribution of the energy in the continuous spectrum. This redistribution has a

profound effect on the continuous spectrum of an A star, as shown by the curve computed by Pannekoek for a temperature $T_0 = 8{,}480°$, and it must have a marked influence on the ionization as well as on the excitation of those elements the ionization potentials of which lie in the region of 12 volts. Research in recent months has led the authors independently to the conclusion that this physical dilution of radiation—as contrasted with the geometrical dilution observed in shells—plays a very important part in a number of problems, and various instances of this are given. A wide variety of unexplained observations are capable of interpretation along the general lines suggested by the authors, details of which are to be published in the *Astrophysical Journal*. Departures from thermodynamic equilibrium are now being emphasized by recent developments in stellar spectroscopy, in contrast to the long and successful period characterized by the use of thermodynamic equilibrium.

Infra-red Baking

A RECENT article by H. Seymour (*The Electrician*, August 21) surveys the present state of the technique of infra-red baking of industrial finishes. The article makes brief reference to early development and mentions that although first patented some seven years ago, radiant heating received little attention until adopted by the Ford Motor Co. It is emphasized that the rate of temperature rise depends primarily on the difference between the energy gain of the stock by absorption of radiation, and the loss of heat by re-radiation and convection; and that the temperature of the stock and its surroundings should be of the same order of magnitude. Depending on the linear absorption coefficient and absorptivity of the film, baking or heating may occur from the inside outwards, the outside inwards, or uniformly throughout the film.

A description is included of the various types of radiant heating lamps, and of their early development; reflectors and their surfaces; and the present trend of design. Reflector surface fouling by dust and fumes receives special mention, while reference is made to a new type of unit with a sealed lens which obviates cleansing, reduces the fire hazard, and avoids reflector surface damage. An intensity survey is included which discusses the possibilities of obtaining uniform energy intensities over surfaces normal to the lamps. The results of recent research into the infra-red absorption characteristics of various paint pigments ground in similar vehicles are given. The conditions for maximum utilization of electrical energy are examined and it is stated that this obtains when the air temperature is higher than the stock temperature. Vapour removal, performance ratio, maximum heat densities and oven arrangements are discussed, and the view is expressed that future practice will utilize radiant heat lamps augmented by auxiliary heaters.

Soldering Electrical Joints

AN article in the *Electrical Review* of August 28 describes the technique and selection of suitable materials. The process of soldering may be defined as the uniting of metals by means of an alloy melting at a lower temperature than their fusing points, as distinct from welding in a state of fusion. The solder alloys with the surface layers of the parts to be joined and the process is not simply one of adhesion. There are two broad classes of soldering, namely, soft soldering in which tin-lead alloys are mainly used and hard soldering in which alloys of copper-zinc (brazing) or of silver-copper-zinc (silver soldering) are employed. Soft soldering is used very extensively in electrical work and silver soldering to some considerable extent; brazing is rarely used. The electrical conductivity of soft and hard solders is considerably less than that of copper, varying with composition between approximately 9 per cent and 13 per cent for soft solders and 20 per cent and 40 per cent for silver solders.

Some or all of the following points must be considered in the selection of soldering processes for joints in current-carrying conductors. (1) Thorough cleansing and adequate heating, but not overheating. (2) As little solder as possible should be used, to obtain low electrical resistance and high mechanical strength. (3) Solder must not weaken at normal working temperatures. (4) Due to high centrifugal forces encountered in many electrical joints (for example, soldered commutator connexions), solder must be both strong and ductile. (5) Fluxes of a corrosive nature must be avoided, and flux residue easily removable. (6) Solders used for joining copper in the manufacture of cables must be strong and ductile to withstand the subsequent drawing operations; silver solders are generally employed. The article gives tables of solder compositions, properties and characteristics.

Health of the Swedish Army

ACCORDING to the August issue of the *Anglo-Swedish Review*, General Ivar Holmquist, Commander-in-Chief of the Swedish Army, has recently declared that, without going into technical details, he was sure that the Swedish soldier was one of the best in the world. What he lacked was only battle experience, but he was at least partly likely to make up for this by his excellent physique. Moreover, the nerves of the soldiers were in good order, they did not suffer from war weariness, the material was in first-class condition and had not been worn out by war, nor had the élite troops been decimated. Although it was deplorable that so much of the country's labour and resources had to be used for military purposes, the effort was not altogether wasted. For the general health of the nation it was important that the young men of twenty should receive one year's excellent physical training in the open air. During a recent tour of inspection among the mountains of Lapland, he was pleased to see with what vitality and enthusiasm these young men carried out a march of 13 miles in alpine terrain rising from 1,000 to 3,000 feet and then delivered an attack down a mountain slope carrying the heavy equipment of machine-guns and trench mortars which had been conveyed on sledges during the march.

Public Health in Peru

IN a recent article (*Bol. Of. San. Panamericana*, **21**, 540; 1942) Dr. Constantino J. Carvallo, the Minister of Public Health, Labour and Social Welfare, gives a description of public health in Peru from December 1939 to July 1941. The chief health problems of this country are malaria, tuberculosis, children's diseases, venereal diseases and other contagious disorders. Health campaigns which have already begun include surveys, health examinations, vaccination, establishment of clinics and dispensaries, early treat-

ment, rural hygiene, drainage of swamps and stamping out foci of infection, port and river sanitation and housing. A department of industrial hygiene was established in August 1940, while nutrition problems are handled by the National Nutrition Administration founded in February 1940.

Zoological Society of London : New Secretary

DR. S. A. NEAVE, C.M.G., O.B.E., director of the Imperial Institute of Entomology, has been elected honorary secretary of the Zoological Society of London to fill the vacancy caused by the resignation of Prof. Julian Huxley. Dr. Neave will hold office until April 1943, when the next annual general meeting will be held. Dr. Neave's work, especially in economic entomology, is well known. He was naturalist to the Geodetic Survey of Northern Rhodesia during 1904–5; entomologist to the Katanga Sleeping Sickness Commission during 1906–8 and entomologist to the Entomological Research Committee (Tropical Africa) during 1909–13. From 1918 until 1933 he was honorary secretary of the Royal Entomological Society and was its president in 1934–35.

Alphonse François Renard (1842—1903)

THE Belgian geologist Alphonse François Renard, who with Murray reported on the rock deposits from the bottom of the sea collected by the "Challenger" expedition, was born at Renaix in East Flanders on September 27, 1842. Educated at Rome for the Church, during 1866–69 he was superintendent at the Collège de la Paix at Namur, and then entered the Jesuit College at the old abbey of Maria Laach in the Eifel. Taking up the study of geology and chemistry, in 1874 he was made professor of those subjects at the College of the Belgian Jesuits at Louvain and a few years later was made a curator of the Royal Natural History Museum at Brussels. Though ordained a priest in 1877, he abandoned his intention of entering the Society of Jesus and separated from Rome, resigned his post at Louvain in 1882 and in 1888 was appointed professor of geology in the University of Ghent, a post he held until his death. In conjunction with Vallée-Poussin (1827–1904) he wrote on the plutonic rocks of Belgium. The Geological Society in 1885 awarded him the Bigsby Medal. He died at Brussels on July 9, 1903.

The Night Sky in October

THE moon is new on October 10d. 04h. 06m. and full on October 24d. 04h. 05m. U.T. The following conjunctions will occur during the month: Oct. 3d. 16h., Jupiter in conjunction with the moon, Jupiter 3° N.; Oct. 27d. 11m., Saturn in conjunction with the moon, Saturn 3° N.; Oct. 31d. 05h., Jupiter in conjunction with the moon, Jupiter 3° N. Occultations of naked-eye stars during the month are as follows, the times referring to Greenwich :

d.	h.	m.			
6	03	44·3	18	Leonis	*R*
26	21	52·3	γ	Tauri	*D*
	23	02·1		Tauri	*R*
27	03	44·7	θ'	Tauri	*D*
	04	24·6		Tauri	*R*
27	04	37·8	75	Tauri	*R*
27	07	51·7	a	Tauri	*D*

On October 11 Mercury is in inferior conjunction and on October 26 will be at an elongation favourable for northern observers, rising about 2h. before the sun. Venus is too close to the sun to be observed during the month. Mars is in superior conjunction on October 6 and is not well placed for observation. Jupiter is favourably placed for observation after midnight, and Saturn, near Aldebaran, rises early in the night, southing about 3h. in the middle of the month.

Announcements

SIR D'ARCY THOMPSON, professor of natural history in the University of St. Andrews, has been elected president of the Royal Scottish Geographical Society, in succession to Lord Rosebery.

THE Lord President of the Council has appointed Sir Lawrence Bragg, Prof. J. E. Lennard-Jones, Dr. A. McCance and Sir Raymond Streat to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research from October 1. Dr. G. M. B. Dobson and Mr. S. K. Thornley will retire from the Council on completion of their terms of office on September 30.

By an Order of the Committee of Privy Council, made after consultation with the Medical Research Council and with the president of the Royal Society, Prof. D. Keilin, Quick Professor of Biology in the University of Cambridge, and Sir Henry H. Dale, retiring director of the National Institute for Medical Research, have been appointed to be members of the Medical Research Council in succession to Prof. L. J. Witts and Prof. C. R. Harington, who retire in rotation on September 30. By the same Order, Sir Charles Glen MacAndrew, M.P., has been appointed to be a member of the Council in succession to the Right Hon. James Gray Stuart, M.P., also from October 1.

DR. HARRISON E. HOWE, editor of the *Journal of the American Chemical Society, Industrial and Engineering Chemistry*, and a trustee of Science Service, has been awarded the Chemical Industry Medal for 1942 by the American Society of Chemical Industry.

MR. F. H. WYNNE retired from the post of H.M. chief inspector of mines on September 20, on reaching the age limit. He is succeeded by Mr. J. R. Felton, who has been the deputy chief inspector since the end of 1937.

DR. FÉLIX AGUILAR, director of the National Observatory, La Plata, Argentina, writes that one of his colleagues, Mr. Gualberto M. Iannini, has undertaken to compute a definite orbit of Comet Whipple, 1942 *a*. He would be very grateful for data, especially from observatories in the northern hemisphere.

THE opening meeting of the new session of the Iron and Steel Institute will be held on October 13, at 2.30 p.m., in the lecture theatre of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, when the president, Mr. W. M. Selvey, will present a short address. This will be followed by the presentation of the Melchett Medal for 1942 to Dr. Arno Carl Fieldner, chief of Fuels and Explosives Services, United States Bureau of Mines. As Dr. Fieldner cannot be present, the medal will be accepted on his behalf by the United States Embassy. The Melchett Lecture, entitled "The Analysis and Testing of Coal in Relation to its Properties and Utilization", will, in Dr. Fieldner's absence, be delivered in the form of a talking film of himself reading it, which will be reproduced in the lecture theatre.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Functions of the Research Associations

SIR LAWRENCE BRAGG'S valuable and thought-provoking address at the Royal Institution on March 26 (NATURE, July 18, p. 75), under the title "Physicists during and after the War", readily recognizes the value and status of industrial research. This will be welcomed by many who are connected with industry, and who often know more of what is going on in the universities than the universities do of what is being done in industry. Unfortunately, there is no doubt justification for his assumption that there does exist, among many university professors, a feeling that industrial research is of an inferior kind. This is mainly through lack of knowledge of the scope and kind of work now covered by the expression 'industrial research'.

Reference is made by Sir Lawrence to the ardent reforms that are in the air, and he discusses among other things the merits of one of the proposals—that new institutions for pure research divorced from teaching should be founded. Is the field not already covered? We have first the celebrated schools of university research, where pure research is carried on usually without any thought of practical application. On the other hand, we have the research laboratories of industrial firms where research is mainly applied, except in the bigger ones (for example, some of those connected with the electrical, metallurgical, textile and chemical industries) which also carry out fundamental work. The missing gap between these two was filled by the inauguration, twenty-four years ago, of the Research Associations. One of the special features of a Research Association is that it is the only organization in Great Britain having a bird's eye view of an industry's problems, and that can therefore formulate its research programme in the best interests of the industry as a whole. I do not see that any advantage would be gained to the State by the formation of a fourth class of research institution of the type to which Sir Lawrence refers, and of the value of which I gather he himself is sceptical. One example of this kind is the suggestion made by Prof. J. D. Bernal in his book "The Social Function of Science" for the foundation of a comprehensive "Fibre Institute". Would such an institution be in a position to do better work than is already done? Without mentioning the mass of research work on fibres carried out (and published) by the textile Research Associations, could the fine work done, for example, by Prof. J. B. Speakman and by Dr. W. T. Astbury at the University of Leeds, be easily improved upon? In so far as such work suffers from lack of equipment, this could be met by giving larger grants for this purpose to existing institutions and not by forming new ones.

Sir Lawrence thinks that the general conditions under which Research Associations work militate against the production of really fundamental ideas. He compares the Research Associations unfavourably in this respect with the universities on one hand and the industrial laboratories on the other. I do not think this is really so; it may be true that the Research Associations as a whole have not devoted as much of their resources to fundamental research as would be desirable, but this is not in my opinion due at all to their organization and the intermediate position they hold between the universities and industry. I rather take the opposite view that this position gives them a unique opportunity to carry out the highest class of fundamental creative work, with contacts with the universities and at the same time a comprehensive mental picture of the central problems of their own industry, while completely free from the rush and bustle associated with industrial production. I suggest that if any of the Research Associations have failed to produce a fair quota of new fundamental scientific knowledge, the explanation is to be sought in lack of resources and not in their organization or position in the scheme of things. It is of extreme importance that a Research Association should maintain a proper balance between the accumulation of fresh knowledge and development of new ideas on one hand, and their application to their own industry on the other. Fundamental scientific work must go on simultaneously with the application of knowledge previously gained. Without big resources it is very difficult, if not impossible, to maintain this condition.

There are still a great number of university teachers who do not realize that research in pure science is not confined to the universities, but no one really familiar with the work of the Research Associations (and possibly, in particular, the larger ones) would, I think, deny that a great deal of purely scientific research is carried out with no other immediate aim than the accumulation of fresh knowledge and with no limitation of the freedom of the individual worker through too much 'direction' from above. Indeed, in one sense I would say the young graduate, after joining a Research Association, is more free than the raw graduate in a university laboratory, who commonly obtains his research training within the limits of his professor's own specialized (and sometimes narrow) field—a system which has led in physics to something akin to inbreeding, and to the scarcity of young physicists who have a first-class general knowledge of 'properties of matter' physics.

Sir Lawrence emphasizes the idea of a Research Association as being "ideally a permanent laboratory with special equipment, but with a changing population, not as being a permanent body of men", and goes on later to refer to the opposite side of the picture "only too commonly seen", of research being "directed" by a Committee, which is too impersonal a body to direct research, and the members of which "are generally too busy and important to give the necessary time and attention to detail".

Too much emphasis can be placed on the idea of a changing population, though I agree that augmentation from time to time of the staff from outside by fresh, unprejudiced minds is highly desirable. But such changes should generally, though not necessarily always, be among the younger research staff, rather than the more senior men. It is not always realized that nearly all the Research Associations are unique in that they serve the older industries which were flourishing trades before industrial research had ever been heard of. It follows from this that one of the first essentials to the success of a Research Association is the complete confidence of the technical men in the industry in the Association's most senior staff, and this can only come about—in the larger industries in any event—through much personal contact and recognition by the industrialists of the intimate knowledge these senior men have acquired through close

study of the industry over a great many years. Constant changes among senior men would do a Research Association a great deal of harm.

As regards research being run by committees, while it is true that research committees do exist, and that they approve the research programme, I have never heard of a case where fundamental scientific work has been hindered through this system. From the very constitution of these committees, the suggestions which come from them are, so far as my knowledge goes, nearly always concerned with *applications* of knowledge the Association has already gained—a field in which they are eminently qualified to make suggestions, often valuable ones.

Sir Lawrence's suggestion that there should be more contacts between research workers in the universities and those in industry has great possibilities. I would therefore extend a cordial invitation to any professors who feel an urge to write about Research Associations, but who may possibly feel that before doing so they would like to know more about them, to visit the Shirley Institute, and form their own opinion of the purely scientific researches carried on there normally in peace-time.

F. C. TOY.

British Cotton Industry Research Association,
Shirley Institute,
Didsbury,
Manchester.
Sept. 1.

I AM too conscious of the lack of contact which has often existed between the university and the industrial researcher not to sympathize with much of what Dr. Toy says on the functions of the Research Associations, and one cannot resent the mild sting which he has permitted himself to add to its tail!

He mentions two difficulties with which the Research Associations have to contend: lack of resources and the fact that for the most part they serve the older industries. As regards the first, it has often been pointed out what a small fraction of our national income we devote to research, as compared with other industrialized countries. As regards the second point, the older industries have a wealth of technical experience, and it is an arduous task for the man of science, using his fundamental knowledge, to surpass the skill and lore acquired by long practice.

Dr. Toy rightly stresses the undoubted fact that in spite of these handicaps much fine original work is done in the Research Associations. Yet on re-reading my own article, I do not feel that Dr. Toy's views are in conflict with its main points, and hope that readers of NATURE will come to the same conclusion. In discussing physics in industry, the last thing I had in mind was a criticism of any particular body of men. I expressed a conviction, and rea firm it, that we have not yet discovered the best way of applying our great resources of native scientific ability to the strengthening of our industrial position.

W. L. BRAGG.

Encouragement of Research in Industry

THE point made by Sir Lawrence Bragg[1], and again by Mr. Benham[2], concerning the need for freedom for scientific work from other interferences, cannot be too highly stressed.

The fact that scientific workers are generally blessed with a good fund of 'common sense' often results in many jobs in industrial establishments being passed over to them for attention, jobs which more properly should be dealt with by other departments of the organization. Their greater technical knowledge of the jobs means that they are better done—but only at the cost of interruption of their proper research or development work. Too often also they are called upon to put right the mistakes of other sections of the business—mistakes which should not have occurred if adequately trained staff had been employed in those sections. Financial considerations, however, doubtless influence this in many instances.

Reluctance of the production staffs to make use of the developments of the research workers is not confined to the senior supervising staff. In many cases it extends down to the foremen, to the charge hands and to the workers themselves. It can only be overcome by the friendliest co-operation between both sections. This co-operation is seldom easy to secure, because they generally talk in different 'languages', and think in different terms.

A good liaison engineer (but one who has no particular flair for research), between the development or research section and the production departments, is probably the best solution. If he has had a little post-graduate research training he will appreciate the finer points and needs of the scientific aspects of the problem; while if he is a good engineer he will be able to translate these into the necessary applications in the manufacturing departments and see that their difficulties—and they will always have difficulties with any new process—are given sympathetic attention.

The suggestion made by Mr. Benham that more use should be made of shorthand typists in research laboratories is a good one, and I should like to endorse it heartily. Provided that they are reasonably intelligent and can be trained to present the data in a proper form and can take some useful action regarding other matters on which they may be given notes during the progress of some investigation, they can be a great asset. Good ones for this type of work are not easy to find. I would suggest further that if mechanical calculating aids are available—and at the very least an adding machine should be 'on tap' in every laboratory—they should be taught to operate them so that their sphere of utility to the research worker can be much increased. In many cases, however, it does not prove easy to convince the management of needs such as these.

This, again, is another argument in favour of Sir Lawrence Bragg's plea that all laboratories should be given authority for certain expenditure entirely without reference to any outside control. The researchers will then quickly get the equipment most useful to them, without the wearisome arguments necessary to justify it to others—who cannot appreciate the real needs of the moment. Only too often is work spoiled or improperly completed on this account.

Finally, as Mr. Benham says, give the researchers more responsibility. If expenditure on the research is justified at all, it is all the more justifiable that the researchers should be given the responsibility and authority to see that their work is properly applied in the production departments. They must rank equal with the production managers and not be entirely subordinate to them.

Nutteries,
Liss, Hants.

PHILIP R. COURSEY.

[1] NATURE, 149, 75 (1942).
[2] NATURE, 150, 235 (1942).

Homology of the Campaniform Organs on the Wing of *Drosophila melanogaster*

In the normal wing of Drosophila the campaniform sensilla have been noted by McEwen[1], and have been shortly described by Hertweck[2] who termed them "*kuppelformige Organe*". They are arranged in well-defined positions which include several large groups at the base of the radial vein; single organs are found more distally on the first and third longitudinal

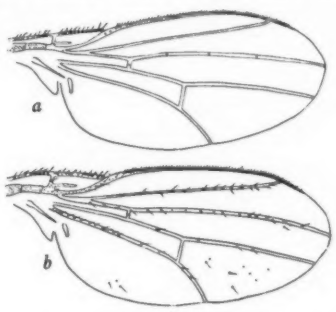


Fig. 1.

a, Diagram of the dorsal surface of a normal wing showing the positions of bristles and campaniform sensilla—the latter are indicated by dots; *b*, the same for a 'hairy' wing. In both, certain ventrally placed sensilla and a large group of sensilla on the extreme base of the wing are omitted.

veins and the anterior cross-vein (Fig. 1*a*). These organs show considerable variation in size, those at the base of the wing being the smallest. When viewed from the side a large sensillum from the distal part of the radius is seen to consist of a cuticular dome

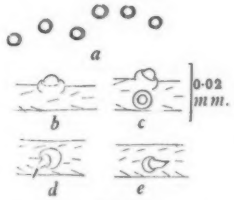


Fig. 2.

a, Surface view of part of a group of small campaniform organs on the base of the radius; *b*, side view of a normal large campaniform organ from the distal end of the radius; *c*, a reduplicated organ: *d*–*e*, structures intermediate between campaniform sensilla and bristles; *c*–*e* are from a 'hairy' wing.

set in a socket-like elevation of the cuticle (Fig. 2*b*). Smaller sensilla from the base of the wing have a similar, though smaller, dome, but the socket-like part of the complex is much less conspicuous and seems to be represented by the rim of a shallow

Fig. 3.

Transverse section through a group of small campaniform organs on the base of the radius in 'hairy wing'; *rn*, radial nerve.

saucer-like depression in which the dome is inserted. All the organs are circular or nearly so. In section their structure is seen to be typical of this type of sensillum (Fig. 3): each is innervated by a single sense cell from which arises a 'sense fibre' which is inserted on the inner side of the dome; the sense fibre with the exception of the tip adjacent to the dome stains deeply with hæmatoxylin, a property which is shared by the inner lining of the dome (the "*Polstermasse*" of German authors).

The non-allelomorphic genes 'hairy' (*h*,3-26.5) and 'hairy wing' (*Hw*,1-0·0), as is well known, control the production of extra bristles on the thorax and wing of Drosophila; in addition, they also exert a very considerable effect—and in general the effects of both genes are very similar—on the wing campaniform organs. This does not appear to have been previously recorded. In these mutants the number of campaniform organs on the wing is greatly increased, for example, a typical 'hairy' wing may carry more than 150 organs compared with the normal complement of some 85. Most of the extra organs are found on or near the base of the radius, although a variable number occur more distally on the other veins or scattered in irregular groups on the intervein membrane (Fig. 1*b*). The most interesting effect, however, concerns the large distal campaniform sensilla, many of which are transitional in form between normal organs and typical bristles (Fig. 2 *d*–*e*); in these the socket-like element remains unaffected but the dome is produced into a small spinous projection. All intermediate stages between normal campaniform organs and fully formed bristles can usually be found on a single wing.

The derivation of the various types of insect sensilla from a central type such as the trichoid sensillum or bristle has sometimes been suggested. In the case of the campaniform sensilla Snodgrass[3] suggests that the bristle may have been lost but the socket retained. From the evidence outlined above it would appear that both elements of the apparatus are retained and that the dome of the campaniform organ is the homologue of the bristle. Unfortunately, the cells which give rise to the campaniform organs are not present in the adult, and, owing to their small size, it has not yet been possible to identify them with certainty in the developing wing. It is known[4], however, that in Drosophila, as in other insects, normal bristles are produced by two cells, one of which, the trichogen, secretes the bristle proper, while the other, the tormogen, gives rise to the socket. It is not improbable that two cells are also concerned in the formation of a campaniform sensillum and that one secretes the dome and the other the raised rim or socket-like part of the complex. When these organs are relatively small as at the base of the wing in Drosophila it is possible that the homologue of the tormogen fuses with the general cuticle or produces at most a shallow rim, rather than secreting a discrete socket-like structure such as is found in the more distal organs. The immediate cause of the normally strictly alternative type of secretion—campaniform dome or bristle—is not clear, but the obvious difference in the amount of cuticular material present in these elements is likely to be reflected in the respective sizes of the formative cells concerned.

These same organs have been wrongly referred to by me as "chordotonal organs"[5]. Observations made on the sensilla and conclusions drawn remain, however, unaffected.

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Sept. 2.

[1] McEwen, R. S., *J. Exp. Zool.*, **25**, 49 (1918).
[2] Hertweck, H., *Z. wiss. Zool.*, **139**, 559 (1931).
[3] Snodgrass, R. E., "Principles of Insect Morphology" (McGraw-Hill, 1935), p. 514.
[4] Lees, A. D., and Waddington, C. H., *Proc. Roy. Soc.*, B (in press).
[5] Lees, A. D., *J. Genet.*, **42**, 115 (1941).

Feeding of the Common Toad

THE accompanying photographs of the feeding of the common toad (*Bufo vulgaris*, Laurenti) supply, I believe, for the first time an accurate description of the tongue movement in an Anuran. The movement in the frog is similar, but I have not so far obtained such satisfactory photographs of it. Most modern text-books assume that protrusion of the tongue is accomplished by lymph pressure. The

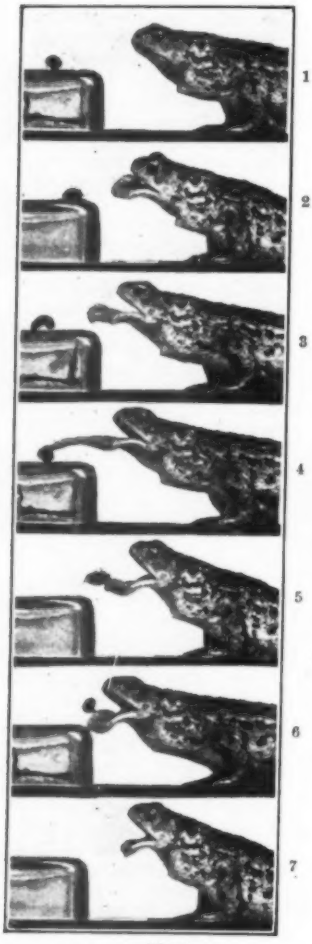

Fig. 1.

TOAD FEEDING: FROM SIDE. RECONSTRUCTED SERIES; NOS. 1, 4, 6 and NOS. 2, 5, 7 ARE CONSECUTIVE FRAMES OF TWO SHOTS. FIG. 2 WAS TAKEN SIMULTANEOUSLY TO THE LAST OF THESE SHOTS. THE PREY IN ALL CASES IS A WOODLOUSE.

Fig. 2.

TOAD FEEDING: FROM ABOVE. TONGUE FULLY EXTENDED.

evidence for that theory is slight[1], and these photographs argue against it and in favour of a muscular mechanism, because (1) the time of protrusion is shown to be so short (sometimes less than 1/20 sec.); (2) the tongue and floor of the mouth show no signs of inflation; (3) there is a distinct constriction at the base of the tongue when viewed from above in the fully extended position (see Fig. 2). These features, and others, suggest a muscular mechanism similar to that proposed by Gaupp[2] on anatomical grounds; with the probability that purely intrinsic muscles play a larger part than he thinks, especially in the unrolling of the tongue and in the first part of retraction. It is still possible that lymph pressure may play a subsidiary part.

The entire movement occupies little more than 1/10 sec., divided nearly equally between protraction and retraction. The dorsal surface (at rest) is here only elongated to about eight sevenths of its length at rest, though other photographs show that it can be elongated slightly more than that. In its other dimensions there is very little change, except that it is slightly narrower when seen from above. The length of the protruded tongue in this female, which measures 3 in., is 8/10 in., from the tip of the lower jaw. Fig. 1, No. 5, shows from the legs of the prey that the tip of the tongue is rotated through 180° at the beginning of retraction.

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Sept. 7.

[1] Hartog, M., *Ann. Mag. Nat. Hist.*, **7**, 7 (1901).
[2] Gaupp, E., *Anat. Anz.*, **19** (1901).

Response to Colour in Birds

APART from some experiments by Marples[1], little work appears to have been done on the colour awareness of birds in their wild state. By colour awareness is meant the ability to detect and react to light of widely differing wave-lengths. The possibility that such recognition may, in birds, involve merely the detection of different intensities of a single shade has not been overlooked, but is contra-indicated by the experiments described here. These experiments have been carried out by utilizing the instinct of nest-sanitation whereby most birds, and especially those of the Passerine order, keep their nests free from contamination by the excrement of the young. This instinct has been shown by Smith[2] to be of the same order of strength as that to feed the young, and the provision at the nest of artificial fæces of various colours gave a ready means of testing the response to colour in certain species. These artificial fæces were made from 'Plasticine' moulded into the shape and size of a fæcal sac, and spectroscopic analysis of the samples employed gave the data shown in Table 1.

TABLE 1.

Colour	Brightness factor	Hue wave-length ($\mu\mu$.)	Saturation
White	0·586	578	0·156
Yellow	0·362	578	0·448
Green	0·222	549	0·348
Red	0·134	492*C*	0·228
Purple	0·116	566*C*	0·006

(*C* = complementary colour.)

The colours are thus far from pure, but this was to be expected from a substance like pigmented 'Plasticine'.

The artificial fæces were placed on the rim of the nest, in a similar position to that used by the nestlings. Their arrangement was quite random, and was changed for each trial. Observation of the order of removal of the artificial fæces was made from a 'hide' in close proximity to the nest. If birds were colour-blind, the order of removal would be in the order

of decreasing brightness factor, since the brightness factor is defined as that attribute of a colour in respect of which it can be classed as equivalent to some member of a series of greys ranging between black and white. The results of trials at nests of the meadow pipit (*Anthus pratensis*) and the yellow wagtail (*Motacilla flava flavissima*) are given in Table 2, and show no correlation with the brightness factor.

TABLE 2. ORDER OF REMOVAL OF DIFFERENTLY COLOURED ARTIFICIAL FÆCES FROM NESTS. ROMAN FIGURES BY ♂ BIRD; ITALICS BY ♀.

Species	Trial	Red	Yellow	Green	Purple	White
Meadow Pipit	*a*	*4*	*3*	1	Ignored	*2*
	b	*4*	*3*	1	5	*2*
	c	*5*	*3*	2	4	*1*
	d	*4*	3	1	Ignored	*2*
	e	*4*	3	*1*	5	*2*
Yellow Wagtail	*a*	5	1	4	3	*2*
	b	5	1	4	3	2
	c	4	1	5	2	*3*
	d	5	2	4	1	*3*

Fig. 1 shows the female meadow pipit removing, during trial *c*, the yellow (*Y*), while the red (*R*) and purple (*P*) fæces remain on the rim of the nest. Fig. 2 shows the male yellow wagtail removing, in trial *d*, the yellow (*Y*), while white (*W*), green (*G*) and red (*R*) remain.

It is evident that, to the meadow pipit, green must appear as a very bright colour, since in four out of five trials it was taken as first choice. Yellow occupies an intermediate position and red and purple are last choices, purple particularly failing to attract attention. With the yellow wagtail, on the other hand, the order of choice was strikingly different. With this pair of birds, the female refused all the artificial fæces except the white ones, but the male readily removed them all. His first choice was yellow in three out of four trials, after which he took purple or white.

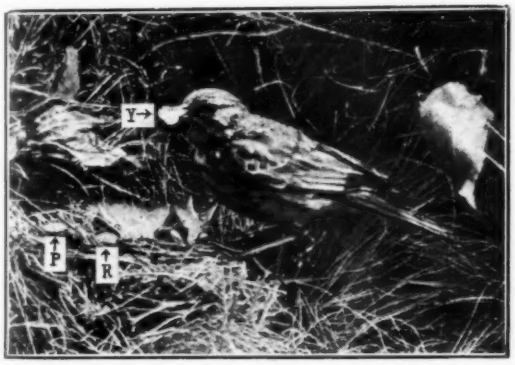

Fig. 1.

In trial *d* purple was first choice. Green, on the other hand, was the penultimate, and red the last choice, three times in four. These results are in striking contrast to those obtained with the meadow pipit, especially in relation to the significance of yellow and purple. Pipits and wagtails are both Motacillidæ, but while the former tend to have dull brown plumages, the wagtails are often brightly coloured with yellow and blue frequently predominating, and although much more experimentation is needed before any conclusive correlation can be made between the colour awareness of birds and their plumage colours, the very obvious pointer to such a correlation cannot be ignored, especially when it is remembered that the yellow wagtail is a sub-species of the basic blue-headed form, *Motacilla flava flava*.

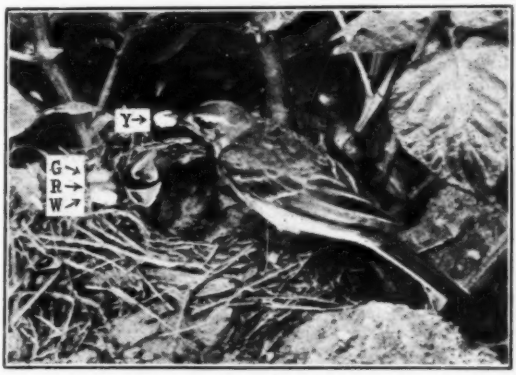

Fig. 2.

The use made of the brighter-coloured parts of their plumage by male birds in nuptial and aggressive display is well known, and in this connexion the work of Lack[3] on the robin (*Erithacus rubecula melophilus*) shows that for this bird, in contradistinction to the two species above, red is a highly significant colour.

These, and other related experiments, will receive detailed treatment in another place.

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Aug. 26.

[1] *British Birds*, **25**, 34 (1931); **26**, 238 (1933).
[2] *British Birds*, **35**, 120 (1941).
[3] *Proc. Zool. Soc.*, **109**, 169 (1939).

A False-Ring Pattern in Larch

DURING the course of the Timber Felling Survey organized by Prof. H. G. Champion, and undertaken for the Forestry Commission by university research parties during the summers of 1940 and 1941, it fell to my lot, as plant pathology member of the Bristol Party, to examine and make counts of the annual rings on felled timber, chiefly European larch.

Such counts, made in the field, proved at first very unreliable owing to the difficulty of determining false, partial or missing rings, and of interpreting the outer rings of suppressed trees. The practice was therefore adopted of taking back from each plot at least one complete cross-section of a butt which was planed and examined in the laboratory. This resulted in the discovery that in nearly all the butts of European larch examined, taken from all parts of the area covered by the Bristol Party, there was a general and recognizable pattern formed by the false rings.

Fig. 1*a* records the percentage of reliably dated annual rings from 1900 to 1940 which showed one or more false rings, including as such everything from slight traces to complete additional rings. It is based upon examination of 105 butts of European larch 25–60 years old. If the false rings on single butts are plotted to the same scale, as shown in Fig. 1*b*, each of the plans so formed will usually fit the master plan best in one position, that corresponding to the correct dating. Exceptions are found in trees with completely unchecked growth, which may have few or no false rings, old trees in which the outer part covered by the established pattern is suppressed, and a few 'oversensitive' butts in which there are so many false rings that the pattern is swamped. In general, the number of false rings appears to vary inversely with the soil depth.

Not only the occurrence of the false rings, but also their number, appearance, and position in any given year's growth, are all of value, and there is now no difficulty in fitting into the pattern any 30- to 50-year-old butt from the south-west region which shows a fair number of false rings. Older trees also show characteristic false rings during their period of maximum ring-width, and the pattern has been tentatively extended back to 1860, but is unreliable owing to the small number of trees examined.

The area from which butts were examined extends very roughly fifty miles round Bristol. The five false-ring plans shown in Fig. 1*b* are from single butts taken from the following localities:

(A) White Hill, near Monmouth.
(B) Pump Ground, Stanway Estate, north-east of Winchcomb, Glos.
(C) Old Hill, near Wraxall, 7 m. west of Bristol.
(D) Huish Cleeve, near Wiveliscombe, Somerset.
(E) Grange Hill Farm, near Basingstoke, Hants. (from a section kindly sent to me by a member of the Oxford Party).

The pattern varies in characteristic fashion from one district to another, but the similarities throughout the area remain more striking than the differences.

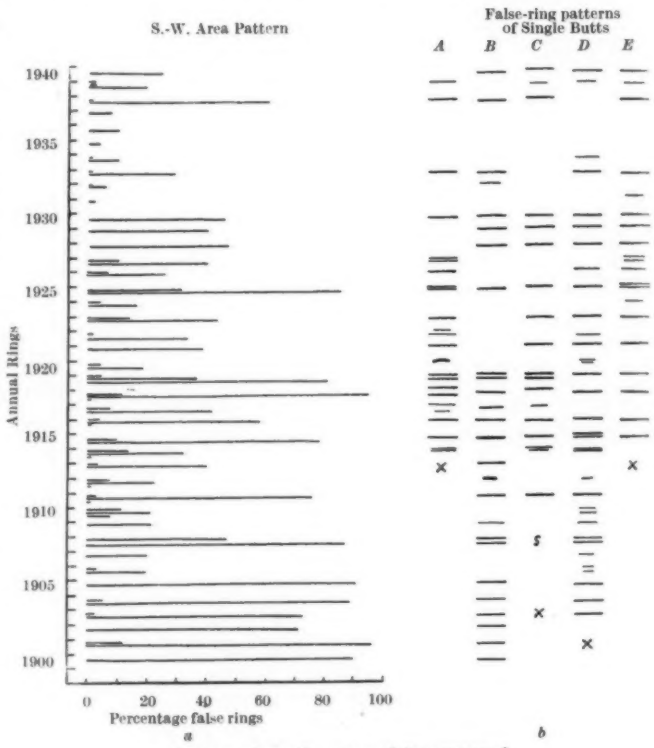
A majority of the butts examined came from the northern part of the area: 26 from the Wye Valley and Dean area, 36 from the Stanway Estate on the Cotswold plateau, 12 m. north-east of Cheltenham, 23 from a few miles west of Bristol, and the remaining 20 from widely scattered places in Somerset, west Wilts, and a few from as far east as Basingstoke and King's Somborne, Hants. The pattern shown in Fig. 1*a* has therefore a strong bias in favour of the local patterns in the northern part of the area. Nevertheless, the chief elements are present throughout the area and it will be of interest to see how widely they extend beyond it.

The most frequent and conspicuous false ring is found in 1918, about the centre of the year's growth; others are in 1938, 1925 (often double), 1919 (often double), 1915 (early central), 1911, 1908 (wide double), and the years 1900–1905, in which, however, the percentages are less reliable owing to the smaller number of records.

Once the probability of occurrence, and the typical position and appearance of the false rings in each year's growth had become known, the pattern was found to be of great practical use in the field. For example:

(1) It provided a check on the ring count, often revealing missing or inconspicuous annual rings which had not been seen or had been misinterpreted.

(2) It gave the ages of trees with suppressed outer rings, and of sections below the felling cuts which did not reach the outside.



x, first year of growth; s, annual ring suppressed.

(3) It enabled the outer ring on fairly recently cut timber or stumps to be dated with certainty, and also gave the dating of rabbit scars and other injuries.

(4) Where enough records had been taken to establish a local pattern it enabled unlabelled sections of butts to be referred to their correct sites.

Nineteen butts of Japanese larch show the same general pattern, with a few differences in emphasis; for example, the 1916 false ring is more frequent than the 1915. Other conifers show the 1918 ring, but the false rings, especially in spruce, are less distinct than in larch, and enough material for the formation of a pattern has not been studied.

It is to be hoped that comparison of the pattern with meteorological records will give some information on the effect of climate on the growth of wood and the formation of additional rings. The relationship, however, is unlikely to be simple. Attempts

to establish a pattern for annual ring-widths, on the lines originated by Douglass and co-workers in the southern United States, failed completely even with trees on the same site. This was not surprising, as moisture can rarely be a limiting factor in the south-west district of England. Certain annual rings, however, notably those for the drought years 1911 and 1921, are often recognizable, apart from false rings, by their relative narrowness, and the firm, narrow outline of the autumn wood. In a damp, variable climate, it is the composite picture presented by the balance and distribution of the large- and small-celled elements in the wood of each successive year's growth, which makes a perceptible pattern worthy of further study.

Once the general climatic pattern is firmly established, the local variations from it will give useful information about soil conditions and the rooting system, and defoliation due to exposure, insect attack, or other local factors. It can scarcely be over-emphasized that the whole history of a tree's growth in relation to its environment is recorded in its wood, and that it needs only the separation of the general from the special elements in that record to make it intelligible.

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The So-called 'Granite Axial Core' of the Himalaya

FROM time to time there appears in various contexts reference to the predominant mass of granitic rock which, it is claimed or supposed, forms the vast bulk of the Great Himalayan Range, and particularly of its highest peaks. In his presidential address to the twenty-ninth Indian Science Congress, 1942, entitled "The Making of India", Mr. D. N. Wadia said: "The sublime snow-capped peaks of the Himalaya from Mount Everest to Nanga Parbat, all are built of this axial granite core", etc. Now specifically, neither Everest nor Nanga Parbat is composed of granite, although veins of granite-pegmatite or -aplite are fortuitously to be found within their essentially sedimentary constitution, which in both cases is made up of slate, quartzite or siltstone, limestone and schist of varying kind.

The time-honoured, but mistaken, view that the main Himalayan axis is thus composed of granite, or intrusive gneiss, is largely due to the early work of General C. A. McMahon, and other investigators, who did not penetrate far into the inner recesses of the main range, and moreover were mostly concerned with its north-western end. Exploratory expeditions of recent years both in the Central and in the Eastern Himalaya have, however, revealed that granite is nothing like so ubiquitous as has been supposed. In the Central Himalaya of Garhwal and Kumaon, in the region dominated by the great peak Nanda Devi, 25,645 ft., and also extending into Nepalese territory, altered sedimentary rocks such as slates, quartzites or siltstones, with crystalline limestone, compose the greater number of the high peaks which have so far been examined in the main range. The same is the case in the Eastern Himalaya, from the neighbourhood of Gosainthan, the great summit on the northern border of Nepal, through Mount Everest and its satellites, and all along the Sikkim- and Bhutan-Tibetan frontier: we find slates, siltstones and limestone—shore facies of the ancient Tethys Sea—constituting the succession out of which the high peaks have been carved. Para-gneisses and -schists are to be found deeply in the lower parts of many of these mountains, but undoubted ortho-gneiss or granite is restricted to the base of the range in certain districts, with granite veins extending upwards in some areas into the sedimentary series.

I may add that this note has been prompted by Mr. Wadia himself, with whom I recently discussed the matter in India, and its intention is to bring before a wider scientific public than geologists alone what has been one of the misconceived ideas of the nature of the Himalaya. Further details of this matter will, it is hoped, shortly be published elsewhere when military duties permit. The recent disastrous loss at sea of field-notes and partially completed papers relative to a large part of my work during three expeditions in the Himalaya will, however, quite preclude anything like a satisfactory rewriting of the vanished papers on Structure, Glaciology, etc.

N. E. ODELL.
Clare College,
Cambridge. Aug. 26.

The Slide Rule Cursor

IT is convenient to be able to check quickly whether the line of a slide rule cursor is accurately at right angles to the scale. We can test the correspondence of a number and its square, but if "log log" scales are available it is preferable to use them as, being further apart, the test is more sensitive.

I have found that 1·55 and 80·0 are almost exactly opposite each other and may be used for the test. The error, being 0·013 mm. in a 10-inch scale, is negligible.

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Aug. 31.

Commission of Forestry Research in Africa

ACTION which, it is hoped, may give rise to a notable advance in the application of the principles of scientific forestry to the practical affairs of the African continent has recently been taken. I write as Editor of the *Journal of the Royal African Society*, which has on several occasions in recent years reflected the strong interest of that Society in the problem of deforestation and soil erosion in Africa by publishing studies of it—notable among them having been contributions by Prof. E. P. Stebbing.

It occurred last year to Prof. Stebbing that the presence in Great Britain of the Belgians and the Free French, controlling between them territories which, with those controlled by Great Britain, form a belt across the whole of Central Africa, offered a unique opportunity for international study of this problem as a whole, which might pave the way in due course to concerted international action.

The Royal African Society was glad to use its good offices to this end, and, the Belgian Colonial Minister and the Free French National Commissioner for Colonies and the Netherlands Minister for Colonies giving their cordial support, an unofficial International Commission of Research, set up to study deforestation and erosion in tropical countries, came into being under the auspices of the Royal African Society, with membership as follows: Prof. E. P. Stebbing (*chairman*); Governor-General Richard Brunot, governor of Mauritania and Chad; Count P.

de Briey, territorial administrator and assistant provincial commissioner, Belgian Congo; L. Borremans, agricultural adviser, Belgian Embassy in London; A. Muhlenfeld, head of the Department for West Indian Affairs, Netherlands Ministry for the Colonies; Sir William Hunt, formerly lieutenant-governor, Southern Provinces of Nigeria.

This Commission of Research held in all eight meetings, the first on January 2 and the final one on April 10. The verbal discussions were supplemented by valuable notes contributed by the members and others on the various aspects of the questions involved.

The final session was devoted to the adoption of a series of resolutions embodying the Commission's recommendations as to the measures necessary to deal with the problems discussed, these problems having been considered under five main heads as follows:

1. The native custom of shifting cultivation.
2. Bush fires, and the native custom of burning the bush.
3. Grazing.
4. Soil erosion, and reservation of forests.
5. Regeneration of poor or exhausted soils.

On each of these problems the Commission put forward its analysis of the position and its practical proposals for measures to cope with that position.

The proceedings and findings of this Research Commission are being circulated by the Royal African Society to the Governments mentioned and to the neighbouring and other Governments concerned with Africa, in the hope that agreed principles, both of doctrine and of practice, may be regarded as having emerged from the Commission's deliberations, and that this may lead to a new concerted effort to rid Africa, and other tropical countries, of a scourge which, unless dealt with, threatens the very habitability by mankind of large portions of the earth's surface.

E. N. CORBYN.

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Aug. 27.

Paracelsus and "Basil Valentine"

To honour the memory of Paracelsus, who died four hundred years ago, the Institute of the History of Medicine at the Johns Hopkins University has issued four of his treatises in English translation. In a review of this volume in NATURE (May 9, 1942, p. 510) the statement occurs that Paracelsus "borrowed much, without acknowledgement, from Basil Valentine". To many of us who have formed a definite picture of Paracelsus's character, plagiarism would seem to be the last fault of which he might be rightly accused, and as this imputation (which has been frequently made since the seventeenth century) nullifies to a certain extent the purpose of the memorial volume, it might be permitted to ask whether this slur upon the character of the great man is well founded.

More than fifty years after Paracelsus's death, treatises somewhat similar to his began to appear which purported to be based on the manuscripts of a nebulous personality called Basil Valentine, who was supposed to have lived in the fifteenth century. The tremendous reading of the famous German historiographer of chemistry, H. Kopp, has failed to detect in the richest libraries any trace of such manuscripts or any contemporary reference to the man, and nothing has come to light since. On the contrary, many of the arguments Kopp uttered tentatively to show that the treatises of the so-called Basil Valentine had been written after Paracelsus were strengthened and enlarged by recent studies; of special importance was the discovery, in 1925, by F. Fritz of a book forming clearly a link between Paracelsus and "Basil Valentine".

To assume that Paracelsus was in possession of copies of "Basil Valentine's" writings, that he (who so much despised literary tradition and based everything on his own personal experience and philosophy) used them secretly for gaining credit without a single one of his many embittered enemies discovering and exposing this fraud, and that these manuscripts then vanished completely with the exception of the copies which about 1600 were put into print and then disappeared too—that does not seem a plausible hypothesis. The boot is evidently on the other leg: those of "Basil Valentine's" works which show similarities with Paracelsus's ideas and discoveries were rather composed by a man living in the later part of the sixteenth (and not in the fifteenth) century, who was familiar with the writings of Paracelsus but anxious not to disclose his indebtedness to this inspiring reformer. The pretence of high antiquity, the only argument in favour of the alternative hypothesis, is so common in alchemistic literature that one can scarcely give it any weight in face of such strong evidence to the contrary.

We have no reason to doubt that throughout his life Paracelsus was faithful to the proud maxim he inscribed to two of his portraits: "*Alterius non sit qui suus esse potest.*"

F. A. PANETH.

University,
Durham.

I AM grateful to Prof. Paneth for pointing out a very misleading—if not entirely false—statement. The Paracelsus question is so obscure, and still so controversial, that it was only on re-reading Dr. Bayon's article in the *Proceedings of the Royal Society of Medicine* of November, 1941, that I realized how strongly the opinion of specialists has turned against the "Basil Valentine" hypothesis. It would have been better to have said: "Some have thought that Paracelsus borrowed . . ."; better still to have said nothing at all about Basil Valentine. For, in the days before universal printing and stringent copyright, to borrow was no sin. The habit was common, and did not seriously reflect upon the borrower's honesty, particularly in a work not specially intended for publication, unless originality was claimed or the amount borrowed extensive.

Furthermore, I was concerned, not with an involved and obscure point of literary controversy, but with the value of Paracelsus's doctrines. A little about these would have been more to the point than a reference to the "Valentine" controversy. I hold that Paracelsus did more for science and philosophy than is generally allowed; far more indeed than Dr. Bayon, for example, would put to his credit. It is true that his work was wild, erratic and mixed with fancy and superstition; in other words, he was not a strictly scientific man. This fault has brought upon him much scorn and criticism, some not altogether deserved. But with all his violence and crudities, he is rich in inspiring suggestions, and I am truly sorry if any word of mine has harmed the reputation of a thinker for whom I have a great and sincere admiration.

W. H. S. JONES.

FEEDBACK AMPLIFIERS

By C. A. A. WASS

THE use of negative feedback to give improved performance in a number of important respects is now a well-established feature of amplifier design technique, and the simple mathematical treatment of an amplifier with feedback has been given by a number of writers. The earliest of these accounts was in a paper by Black[1], who showed that if an amplifier has a voltage gain of μ times, and an attenuating network is connected between the output terminals and the input terminals in such a way that a voltage equal to a fraction β of the output voltage is connected in series with, and in opposite phase to, the input voltage, the amplifier gain will be reduced in the ratio $1/(1-\mu\beta)$; but at the same time the distortion voltages for a given fundamental output will be reduced in the same ratio.

Besides reducing the distortion, negative feedback reduces the rate of change of amplifier gain with changing supply voltages, reduces some kinds of noise which originate in the amplifier, and can be used to flatten, or otherwise modify, the frequency response. It also has the effect of changing the effective impedance at points where the β circuit is connected to the amplifier, and has been used in this way to reduce the impedance of a pentode output valve so as to give better loud-speaker damping, and also to increase the input impedance of valves in high-frequency amplifiers.

It is clear, then, that negative feedback has great attractions for amplifier designers, especially as the explanations often given suggest that the application of feedback is quite a straightforward matter. It is only necessary, apparently, to feed back a voltage from the output terminals via an attenuating network to the input terminals, making sure that this voltage is in the 'right phase' to give reduced gain, and all the benefits follow automatically. Unfortunately, attempts to do this often result in the amplifier becoming unstable, particularly if more than a very modest degree of feedback is aimed at or if the effective frequency range of the amplifier extends above a few kilocycles per second. To understand this trouble, and to determine whether or not it can be overcome, a more rigid mathematical treatment than that mentioned earlier is required.

The simple mathematical treatment as usually given assumes—often tacitly—that μ and β are simple numbers, implying that neither the amplifier nor the feedback network cause any change of phase of the signals they transmit. Actually, although this may be approximately true near the middle of the working frequency band, phase-shifts always occur at higher and lower frequencies because changing phase is inseparable from falling gain. If the phase characteristics as well as the gain and attenuation characteristics of the amplifier and feedback network are taken into account, a much more useful and comprehensive statement of the effects of feedback can be obtained. Black's paper deals also with this more complex version of the problem, but the results seem to have received comparatively slight attention.

To find the effects of phase-shift in the amplifier, it is convenient to regard the quantity μ as a vector, of which the modulus $|\mu|$ represents the voltage gain of the amplifier and the angle represents the phase shift through the amplifier. Similar considerations apply to β. A signal which passes once through the amplifier and then once through the feedback network suffers a change of magnitude $|\mu\beta|$ times, and the corresponding change of phase is ϕ, say. ϕ does not include the fixed 180° per valve, which can be disregarded for the present purpose. It will be seen that $\mu\beta = |\mu\beta| \cos \phi + j |\mu\beta| \sin \phi$, where $j^2 = -1$.

The gain of the amplifier is still changed in the ratio $1/(1-\mu\beta)$ when feedback is applied, but the quantity $(1-\mu\beta)$ is now to be regarded as a vector. If the modulus of $(1-\mu\beta)$ is called R, it will be seen that $R = |1-\mu\beta|$ which is equal to ratio of gains before and after feedback is applied, and it can be shown that $R^2 = 1 - 2|\mu\beta| \cos \phi + |\mu\beta|^2$. This equation represents a family of concentric circles of radii R and centre at the point (1, ô). To interpret this equation a diagram is prepared by drawing a number of circles with radii greater than, equal to, and less than unity, with a common centre at the point (1, ô), using polar co-ordinates.

This simple diagram can be used to predict the change of gain resulting from the application of any degree of feedback to any amplifier under a fixed set of conditions provided that $\mu\beta$ is known completely, that is, provided that both $|\mu\beta|$ and ϕ are known. A line of length $|\mu\beta|$ is drawn from the origin at an angle ϕ, and the position of the end of this line with respect to the family of circles indicates the change of gain due to feedback. Thus if the line ends on the circle of radius 5, it means that the gain will be reduced by five times; if the line ends on the circle of radius 0·25 it means that the gain will be made four times greater; if the line ends on the circle of unit radius the gain will be unaltered when feedback is applied. It will be seen at once that the unit-radius circle is of special importance as the boundary between regions of 'negative' feedback, which reduces the gain, and 'positive' feedback, which increases the gain, and of course the region of positive feedback is restricted to points within the circumference of the unit-radius circle. This represents a considerable modification of the usual statement that feedback is negative when ϕ is in the neighbourhood of 180° and positive when ϕ is small or zero. This statement, while being useful as a rough-and-ready guide, gives no indication of what happens when ϕ is, say, about 90° or 270°; moreover, although it is true that feedback is always negative when ϕ lies in the neighbourhood of 180°, or more accurately between 90° and 270°, feedback is not always positive when ϕ is zero. Thus if $\phi = 0$ and $|\mu\beta| > 2$, the line representing $\mu\beta$ will lie along the reference line and it will end at a point outside the unit-radius circle. From what has been said before, this will correspond to a reduction of gain, that is, the feedback will be negative. This is a somewhat surprising result, and if a physical interpretation is sought, it seems at first sight that in an amplifier in which these conditions obtain the voltage fed back from the output terminals through the β circuit to the input terminals is more than twice as large as, and exactly in phase with, the input voltage, so that the net input voltage to the amplifier is apparently more than three times as great as before feedback was applied; yet the amplifier gain is reduced. The true explanation is that the phase of the output voltage is changed by 180° when feedback is applied, so that the feedback voltage is in opposite phase to the input voltage. This case is, of course, of little practical importance because it is difficult to realize the required conditions of $|\mu\beta| > 2$ and $\phi = 0$ in a

stable amplifier. It is of interest, however, because it prepares the way for a complete statement of the conditions for stability in an amplifier with feedback. This statement is embodied in Nyquist's criterion, which can be explained with the help of the circle diagram.

Suppose in the case of an amplifier working under constant conditions with a certain degree of feedback, the value of $\mu\beta$ is known over the whole range of frequencies from zero to infinity. Now if a series of lines representing $\mu\beta$ at various frequencies is drawn on the circle diagram and a smooth curve is drawn joining the ends of these lines, the curve will form a closed loop beginning and ending at the origin, since $\mu\beta = 0$ at zero and infinite frequencies (direct current amplifier amplifiers being excluded). Nyquist's criterion, which is based on theoretical considerations, says that if the point $(1, \delta)$ lies inside the loop the amplifier will be unstable; if the point lies outside the loop the amplifier will be stable. The loop may have a complicated shape, and could, for example, have a lobe crossing the $\phi = 0$ line at two points beyond $(1, \delta)$, and it is seen that the case discussed earlier in which $\phi = 0$ and $|\mu\beta| > 2$ is theoretically possible in a stable amplifier.

As a check on Nyquist's work, Peterson, Kreer and Ware[2] built an amplifier in which the $\mu\beta$ loop had a lobe of this kind, and it was found to be stable.

In practical amplifiers it is often unnecessary to plot a complete $\mu\beta$ loop, and indeed a single point can sometimes be very useful. Thus, if the frequency at which $\phi = 0$ can be found and the value of $|\mu\beta|$ at this frequency is measured or calculated, it can generally be assumed that the amplifier will be stable if $|\mu\beta| < 1$ and unstable if $|\mu\beta| > 1$, since lobes are unlikely to occur in straightforward amplifiers. If $|\mu\beta| > 1$ at $\phi = 0$ it is often possible, by examining the loop in this region, to find some way of reducing $|\mu\beta|$ without appreciably affecting the performance of the amplifier in the working band. It must be realized, however, that for a given frequency band the degree of feedback possible in a stable amplifier is a fixed finite quantity which cannot be exceeded no matter what number of complicated phase-correctors and other devices are used. The estimation of this quantity is dealt with in a paper by Bode[3] which gives a complete method, based primarily on Nyquist's criterion, for the theoretical design of a negative feedback amplifier.

[1] Black, H. S., "Stabilised Feedback Amplifiers", *Bell System Tech. J.* (Jan., 1934).

[2] Peterson, Kreer and Ware, "Regeneration Theory and Experiment", *Bell System Tech. J.* (Oct., 1934).

[3] Bode, H. W., "Feedback Amplifier Design", *Bell System Tech. J.* (July, 1940).

CONICAL REFRACTION

By SIDNEY MELMORE
Yorkshire Museum

AN interesting paper on this subject by R. Potter appeared in the year 1841[1]. He "chiefly worked with an eye-lens, or else for micrometer measures with a compound microscope" and his conclusions (which are easily verified) are contained in the following passages: "The luminous ring is seen, and seen perfectly only, when the lens is so placed in its distance from the crystal, that what he [Lloyd] calls the two rays, are, in fact, the two virtual images of the luminous point on the first surface. The position of these virtual images within the crystal is found by the formulæ of geometrical optics, their distance from the second surface, when the incidence is nearly perpendicular, being equal to $\frac{\text{thickness of the plate}}{\text{refractive index}}$."

"Whether we draw the eye-lens away from the crystal, or push it nearer, we find similar appearances, and we see that the ring was formed by the intersection of two cones (or more correctly of two series of cones), the one converging so as to have the bright spot, we formerly found on the second surface, for its vertex, and the other diverging, and having the ring, formerly found on the second surface, for its base."

From these quotations it is evident that Potter was well aware of the possibility of extending the Duc de Chaulnes's method to the study of anisotropic media; but he gives no practical details, and the full development of this method is due to Sorby[2].

There is no reference to conical refraction in Sorby's papers; but they contain a description and figure of an effect directly due to it, which he left without investigation as a "curious appearance".

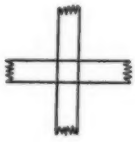


Fig. 1.

Fig. 2.

Fig. 3.

I observed the effects described below when using a plate of aragonite 8·1 mm. thick (cut approximately perpendicular to an optic axis) standing over a pinhole 0·09 mm. in diameter made in a piece of tin foil and viewed under a microscope provided with a 1-in. objective. When the crystal is set so that the refracted rays travel along the acute bisectrix, a cross is seen (Fig. 1); and when viewed through an analyser, first one bar and then the other is extinguished as the analyser is rotated, and the extinction takes place simultaneously at every point in the bar. On tilting the crystal about an axis perpendicular to the optic axial plane, one of the bars gradually becomes curved (Fig. 2). When the tilt amounts to about $6\frac{1}{2}°$ from the acute bisectrix it is apparent that the curved bar is no longer extinguished simultaneously at all its parts, and on closer examination it is seen that the extinguished part of the curve moves through double the angle that the analyser is rotated. By tilting about $8\frac{1}{2}°$ from the bisectrix, the appearance figured by Sorby is seen (Fig. 3). The ring is due to the hollow cone of rays diverging from a focal point considerably out of focus, and the centre of the figure represents the other focal point nearly in focus. The light of each cone is polarized according to the Hamilton-Lloyd law. By altering the focus, the figure changes into an elliptical ring. About $16\frac{1}{2}°$ from the acute bisectrix (that is, in the region of the optic axis), the cones from the two focal points intersect and form a ring approximately circular. In this position the two images of the pinhole lie one above and the other at a nearly equal

distance below the plane of the ring and in a line nearly perpendicular to it.

No great accuracy is claimed for the angular measurements given above, but they are sufficient to show that the two features characteristic of conical refraction, namely, a curved wave-front and a particular state of polarization, appear soon after the acute bisectrix is passed and become progressively more complete and intense as we approach an optic axis. The Fresnel wave-surface accounts for a sudden change from point contact to circular contact of a tangent plane, but some modification of it seems necessary to account for a progressive change: what form this modification should take it is difficult to see.

After considering the subject of conical refraction, Stokes concluded: "We see, therefore, that the limitation of the number of tangent planes to the wave-surface, which can be drawn in a given direction on one side of the centre, to two, or at the most three, is intimately bound up with the number of dimensions of space; so that the existence of the phenomenon of internal conical refraction is no proof of the truth of the particular form of wave-surface assigned by Fresnel rather than that to which some other theory would conduct[3]."

Clifford hoped that useful results would flow from the application of the elliptic geometry of space: "I am", he wrote in 1870, "endeavouring in a general way to explain the laws of double refraction on this hypothesis, but have not yet arrived at any results sufficiently decisive to be communicated[4]."

No results are to be found among his published papers.

There is a rather obscure passage in Potter's paper suggesting the existence of a real focus outside the crystal, but it is doubtful whether this represents a record of observation or an inference from theory. Sir C. V. Raman has, however, recently obtained conclusive proof of its existence, and he finds that "the usual explanations of conical refraction do not go deep enough into the physical aspects of the problem"[5].

Hamilton himself wrote to Lloyd on January 1, 1833: "It is much for theory to have predicted the *facts* of conical refraction, but I suspect that the *exact* laws of it depend on things as yet unknown"[6].

[1] Potter, R., *Phil. Mag.*, **18**, 343 (1841).

[2] Sorby, H. C., *Min. Mag.*, **1**, 193, Pl. vii, Fig. 10 (1877); *ibid.*, **15**, 189, Fig. 7 (1910).

[3] Stokes, G. G., *Rept. Brit. Assoc. for 1862*, 253 (1863).

[4] Clifford, W. K., *Proc. Camb. Phil. Soc.*, **2**, 157 (1876); reprinted in "Mathematical Papers", 21 (1882).

[5] Raman, C. V., and Nedungadi, T. M. K., NATURE, **149**, 553 (1942).

[6] Graves, R. P., "Life of Sir William Rowan Hamilton", vol. 1, 630 (1882).

CENTRAL SCIENTIFIC AND TECHNICAL BOARD

A MEETING was called by the Association of Scientific Workers on September 4 to discuss and support the proposals for a Central Scientific and Technical Board. These proposals had been the subject of a Motion on the Order Papers of the House of Commons for which, according to *The Times* of September 9, 126 signatures of members of Parliament had been obtained.

The papers and discussion at the meeting showed that more scientific workers and engineers consider that there is a real need for a Central Board to link science to the central direction of the War, and two main reasons were given. The first was that our scientific resources are not being used as efficiently as they should be. The question of duplication of work and the problem of those who consider that their work is not of immediate importance to the war effort, as well as the lack of consultation of technical staffs on technical questions affecting production, were all mentioned in this section. The second main contention was that as scientific and technical considerations permeate every sphere with which the War Cabinet must be concerned; that, as in fact science affects strategy and strategy must determine scientific development, it is essential that technical advice shall be immediately available to the War Cabinet.

Mr. A. L. Bacharach, in the chair, referred to the responsibilities facing the Association, not only to gain better conditions for scientific workers but also to improve the role of science in the community. Although the Association is a trade union, by virtue of the peculiar position enjoyed by science the Association has a moral obligation towards society, and cannot separate the status of scientific workers from the status of science.

Lord Strabolgi said that many of the present difficulties facing the United Nations are directly traceable to the fact that we have not yet begun to use fully the scientific man-power of the nation. In modern war, machinery and equipment have a tremendous importance and without them the bravest men are helpless. It is not a question of insufficient funds having been at the disposal of the Service Department but rather the question of the proper use of funds. He considers that only the Air Ministry has taken full advantage of science; not only has it got its own scientific departments but it has also drawn most freely on outside men of science. He paid a tribute to the rapidity with which the Admiralty has found remedies for new devices sprung upon us by the enemy, but holds nevertheless that the Admiralty suffers through being a closed department and not taking advantage of outside developments. We have greater scientific knowledge and experience in Great Britain than in the whole of the Axis Powers: it is only waiting to be used.

Mr. Swann, referring to the investigations made by the Association into conditions in industry and Government service, said these showed conclusively that in a number of important respects the scientific and technical resources of the country were not being used to the full in the war effort. In its proposals for improving the position the Association has received support from many other bodies and a number of detailed improvements have been made during the last six months. These have, however, not by any means fulfilled the stated need for better organization of scientific and technical workers.

Technology is concerned with the processes of manufacture and their improvement and is an essential factor in production itself. New developments are the constant concern of the research and development establishments under the Supply Ministries, in industry and the universities, and these developments need to be closely linked with production. Science is also concerned with the equipment when it is made, how it works in practice and what modifications are necessary. Science is also concerned with the community, its food, its health, its protection from air attack, etc. All these functions of science and technology are divided up in the

various Government departments and industry; yet all these functions are related, and all are affected by the main strategy of the War. Strategical considerations determine which scientific problems are the most important; and conversely, the strategy of the War may be changed by scientific developments.

There is a great need for a body of scientific men who can indicate what assistance science can give to the development of strategy, who can interpret in technical terms the requirements of the strategy decided upon, and who can co-ordinate the scientific and technical work in the various Government departments and in industry. Such a body would need to be a full-time body, in direct contact with the War Cabinet, and with powers to obtain all necessary information on the resources and problems in the scientific and technical field; with the authority to initiate programmes of work and to have direct access to working scientists and engineers. The Association's proposals for a Central Scientific and Technical Board included these functions and powers. Mr. Swann pointed out that while many non-technical people spoke of men of science as 'inventors' the problem of the individual inventor is a special one, and is already very well provided for. Only a small proportion of the scientific discoveries made in this or any other country are due to individuals working on their own; the majority of discoveries are made by teams of workers in research and development establishments, either in Government service or in industry. It is these people who provide the bulk of scientific workers in Great Britain and with whom we are concerned in discussions of planning.

Other speakers from the platform and those who joined in the discussion from the floor all contributed arguments demonstrating the need for central planning in their own fields of work. Mr. D. T. Waigh spoke for men of science in industry, who, he claimed, represent the great majority of our scientific man-power. The scientific and technical staff have a fund of initiative and use it wherever they can; but they are often frustrated in their efforts through the existence of overlapping, lack of consultation and the feeling that their work is not co-ordinated into an effective whole.

Dr. D. McClean spoke of the need for planning in the biological sciences. He mentioned the absurd and damaging distinction between academic institutes and commercial undertakings, many of which are doing first-rate research and are at present the only organizations capable of translating laboratory processes into large-scale production. Bodies such as the Medical Research Council and the Agricultural Research Council are doing excellent work in their own institutes and by subsidizing research as well; but have never accepted responsibility for directing the national effort in the medical, veterinary and agricultural fields.

Mr. Innes spoke of the difficulties encountered by operational research groups, which are in general doing such good work. He considers that there is a need for combination between the different branches of the Services to avoid overlapping and waste of energy. The groups do not get sufficient guidance as to what is required, and for the efficient prosecution of their work they need knowledge of the research and production development that is actually being carried out on military equipment. Any central body must have its roots in working scientists and there must be close liaison with the scientists working for the Forces. To the working scientist it appears that there is not sufficient policy decision on how our scientific man-power should be used.

The day after the meeting reported above it was announced that three full-time scientific advisers had been appointed to the staff of the Ministry of Production (see NATURE of September 12, p. 301). While the Association welcomes these appointments as a step to link science with production, it is certainly not clear from the official announcement whether the scope of activities of the three advisers will be wide enough to answer the demand for a Central Scientific and Technical Board. Questions which are bound to be asked are: what powers the advisers will have to get information and to put their recommendations into practice, whether it will be possible to extend their work to include the scientific and technical activities of the Service Departments and other Ministries outside the strict field of production, what the position of the Lord Privy Seal will be in supervising the work of these advisers, and their relationship with the War Cabinet and the Minister of Production. Until these and other questions are answered in practice, those who have supported the call for a Central Scientific and Technical Board will no doubt continue to voice their demands for something wider than the appointment of advisers to a single Minister.

FORTHCOMING EVENTS

Saturday, September 26

SOCIETY OF CHEMICAL INDUSTRY (JOINT MEETING OF THE MANCHESTER SECTION AND THE FOOD GROUP) (in the Reynolds Hall, College of Technology, Manchester), at 2.30 p.m.—Dr. L. H. Lampitt: "The Preservation of Foodstuffs".

Monday, September 28

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (in the Chemistry Lecture Theatre, The University, Leeds), at 6 p.m.—Dr. E. C. W. Smith: "Incendiary Materials".

Thursday, October 1

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. C. L. Fortescue: Presidential Address.

Saturday, October 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. David Williams: "Mineral Resources of the U.S.S.R.".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, The University, Manchester 13 (September 30).

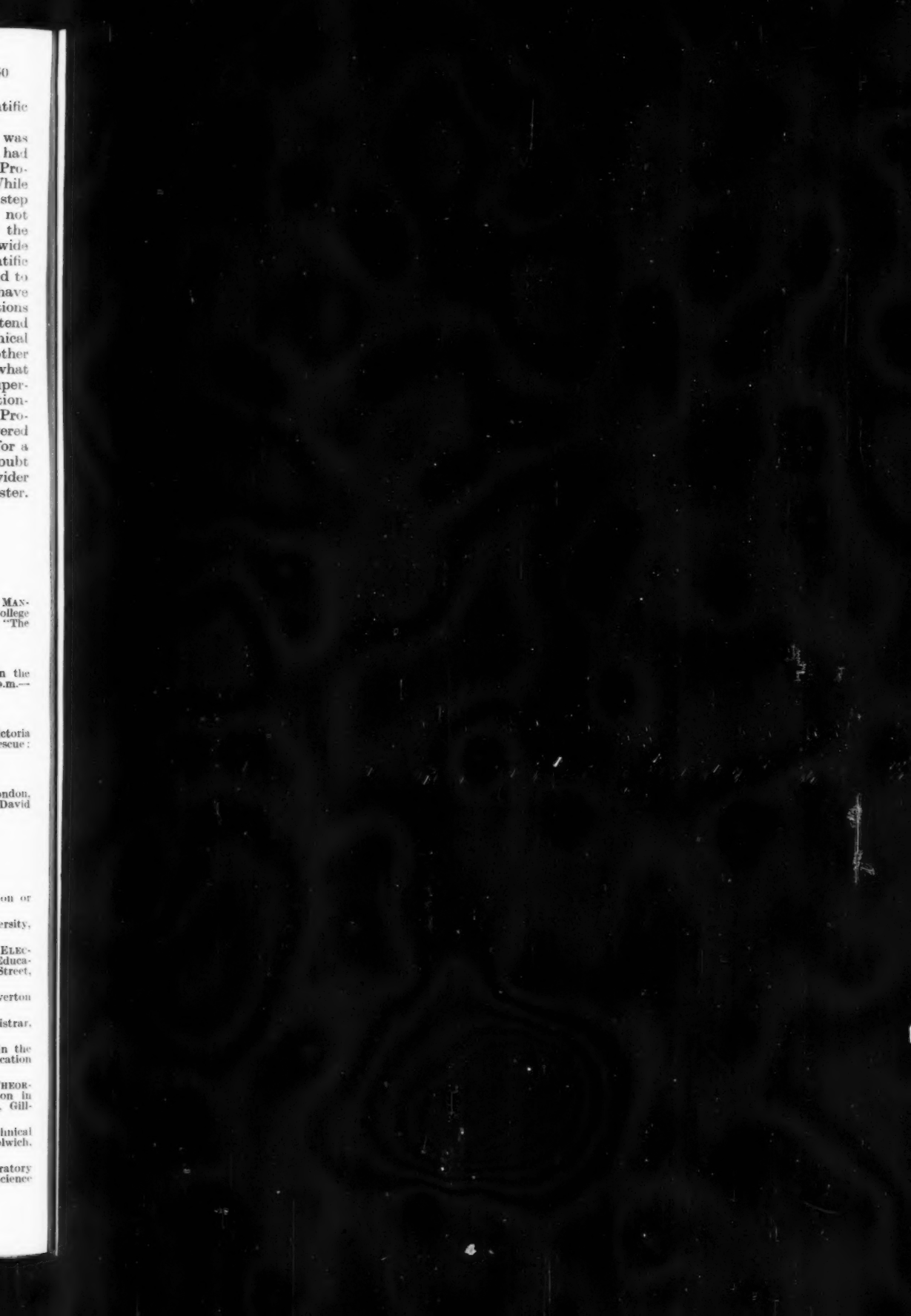
PRINCIPAL TEACHER OF ENGINEERING (MECHANICAL AND ELECTRICAL) in the Technical College, Coatbridge—The Director of Education and Deputy County Clerk, Lanarkshire House, 191 Ingram Street, Glasgow, C.1 (October 2).

TEACHER OF ELECTRICAL ENGINEERING—The Principal, Wolverton Technical College, Wolverton, Bucks. (October 3).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (October 5).

LECTURER IN MECHANICAL OR ELECTRICAL ENGINEERING in the Cannock Chase Mining College—The Director (H), County Education Offices, Stafford (October 14).

ASSISTANT MASTER TO TEACH MACHINE SHOP PRACTICE, THEORETICAL AND PRACTICAL—The Principal for Further Education in Gillingham, Medway Technical College, Senior Departments, Gillingham.

LECTURER (MAN OR WOMAN) IN MATHEMATICS for the Junior Technical School for Boys—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

STEWARD FOR ORGANIC CHEMISTRY DEPARTMENT—The Laboratory Superintendent, Chemistry Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.